BRL 5607
25-10-2016

Evaluation Guideline

For the KOMO® (technical approval-with-)product certificate of

Plastic piping systems of PE-RT intended for heating installations: radiator connections

Set up by CvD LSK d.d. 11 July 2016

Accepted by the KOMO Quality- and Certification Commission d.d. 25 October 2016

Preface Kiwa

This Evaluation Guideline has been prepared by the Kiwa Board of Experts LSK, in which the parties interested in the field of plastic piping systems of PE-RT intended for heating systems: radiator connections, 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.

Kiwa will use this Evaluation Guideline in conjunction with the Kiwa Regulations for Product Certification. 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.

Binding declaration
This Evaluation Guideline is declared binding by Kiwa per 25 October 2016.

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Preface

This amendment sheet belongs to the evaluation guideline BRL 5607 “Plastics piping systems of PE-RT intended for heating installations: radiator connections” dated 25 October 2016 and shall be used by the certification institutes which are accredited by the Dutch Accreditation Council (RvA), or have submitted an application for this, and which have a license agreement with Stichting KOMO, as a supplement for the handling when dealing in addition to the evaluation guideline with applications for the issue or maintenance of a (technical approval-with-)product certificate for plastics piping systems of PE-RT intended for heating installations: radiator connections.

This amendment sheet is:

- Validated by the Board of Experts LSK d.d. 10-09-2021
- Accepted by KOMO Kwaliteits- en Toetsingscommissie d.d. 03-11-2021

Description of the change

In the evaluation guideline the following parts have to be changed:

- Add paragraph 1.3 and 9.1 as stated in this amendment sheet
- Renumber paragraph 1.3, 1.4 and 1.5 to paragraph 1.4, 1.5 and 1.6
- Replace current §1.3 (→1.4) by §1.4 in this amendment sheet
- Replace current §1.4 (→1.5) door §1.5 in this amendment sheet
- Replace paragraph 1.1, 1.2, 4.2, 4.3 Table 2, 5.1.1 Table 3, 5.2.5.2 Table 7/8/9/10/11 by the paragraphs and tables in this amendment sheet
- Change paragraph 9.2 as stated in this amendment sheet

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 a license agreement with Stichting KOMO, when dealing with applications for the issue or maintenance of a (technical approval-with-)product certificate for plastics piping systems of PE-RT intended for heating installations: radiator connections.

The technical field of this evaluation guideline is: F2 piping systems.

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.

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 applied in piping systems for hot water distribution for heating installations: radiator connections at a design pressure (= maximum operating pressure) of 6 bar (7 bar absolute or 6 bar overpressure) or 10 bar (11 bar absolute or 10 bar overpressure) under the conditions mentioned in table 1.

Remark:
Each pressure mentioned in this evaluation guideline is defined as overpressure.
(So, with "6 bar" a "6 bar overpressure" is meant).

Table 1 – Temperature profile during 50 years

	Temperature [ºC]	Lifetime	Overall service coefficient
T_{cold}	20	14 years	1,25
T_{design}	60 + 80	25 years + 10 years	1,5
T_{max}	90	1 year	1,3
$T_{malfunction}$	100	100 hours	1,0
Remark: the mentioned temperature profile is in accordance with class 5 of ISO 10508.			

1.3 Validity

This amendment sheet is an addition to the associated evaluation guideline.

(Technical approval-with-)product certificates issued on the basis of that evaluation guideline retain their validity.

New (technical approval-with-)product certificates may be issued on the basis of the above mentioned version of the evaluation guideline for a period of maximal 6 months after publication of this amendment sheet.

The validity period of the (technical approval-with-)product certificates is indefinite . The validity period can be restricted (ended) by:

- A change of this evaluation guideline,
- Failure of the certificate holder to meet his obligations.

1.4 Relation to European Regulation construction products (CPR, EU 305/2011)

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

1.5 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 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.

4.2 Performance requirements

- The system needs to be adequately resistant to oxygen permeability
- All joints need to be leak proof and sufficiently tight to endure external influences as tested according table 2
- All parts of the system (except the corrugate protection pipes) are required to be designed to have a life expectancy of 50 years at a temperature profile in accordance to class 5 from NEN-ISO 10508, at an operating pressure of 6 bar or 10 bar.
- The corrugated protection pipes have to protect the medium pipes for radiator connections incase the medium pipes are imbedded.

Par 4.3 Table 2

Aspect	Requirements	Test parameters			Test method
Resistance of mounted assemblies to temperature cycling	no leakage	5000 cycles Tmax = (95 ± 2) °C Tmin = (20 ± 2) °C tcyclus= 30 min [1] p_D (bar) Pre-stress = 2,2 MPa One test piece			NEN-EN-ISO 19893
Resistance to pull-out under constant longitudinal force	no separation of pipe and fitting no scratches or breakage within the distance d (= diameter of the pie) on the pipe and fitting	t = (60 ±1) min. 3 test pieces F = 1,5 x π/4 x Dn^2 x 1 (N) D_n in mm			NEN-EN-ISO 3501
Leaktightness under vacuum	Δp ≤ 0,05 bar	t = (60 ± 1) min. 3 test pieces p= -0,8 bar			NEN-EN-ISO 13056
Leaktightness under internal pressure of assemblies subjected to bending (D_n >32 mm)	no leakage	t = (60 ± 1) min. 3 test pieces			NEN-EN-ISO 3503
		p_D	Test pressure[2] (bar)		
			PE-RT Type 1	PE-RT Type 2	
		6 bar	24,8	22,6	
		10 bar	41,4	37,6	
Resistance to inner water pressure (strength joints)	no leakage	t = 1000 h. T = 95°C Minimum of 3 test pieces			NEN-EN-ISO 1167-1
		p_D	Test pressure[2] (bar)		
			PE-RT Type 1	PE-RT Type 2	
		6 bar	8,7	7,5	
		10 bar	14,4	12,4	
Oxygen permeability [3]	≤ 1,8 mg O_2/m^2.dag	20 meters of pipe with 4 fittings 80 °C			NEN-ISO 17455

[1] $t_{cyclus} = t_{Tmax} + t_{Tmin}$ ($= 15^{+1}_{0} + 15^{+1}_{0} = 30^{+2}_{0}$) minutes. Total time = 2500 hours)

[2] For design stress see clause 4.5.2.

[3] Because the required value is expressed in a surface area unit, it is sufficient to measure the smallest diameter of the diameter series of the manufacturer (as long as the same wall thickness of the barrier layer applies to all diameters). For the purpose of inspection also other diameters can be tested

Par. 5.1.1 Table 3

Aspect	Requirement	Test parameter			Test method
Material fitting body	relevant product standard for the plastic used	IQC [1]			Information producer
Long-term strength material fitting body	≥ design stress (σ_D) according to the relevant product standard of the plastic at class 5	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 the aid of NEN-EN-ISO 9080
Appearance	Smooth, without any irregularities	Flawlessness			Visual assessment
Dimensions	Specification producer	Construction drawings			NEN-EN-ISO 3126
Rubber	BRL 2013	BRL 2013			BRL 2013
Degree of cross linking (for PE-(MD)X fittings)	PE-(MD)Xa ≥ 70% PE-(MD)Xb ≥ 65% PE-(MD)Xc ≥ 60% PE-(MD)Xd ≥ 60%	Degree of cross linking			NEN-EN-ISO 10147
MFR (for PPR fittings)	≤ 30% difference with respect to granulated material	Mass 2,16 kg Temperature 230 °C Test period 10 min			NEN-EN-ISO 1133-1
MFR (for PB fittings)	≤ 30% difference with respect to granulated material	Mass 2,16 kg Temperature 190 °C Test period 10 min			NEN-EN-ISO 1133-1
Resistance to internal pressure : Thermal stability material fitting body	Test time > 8760 h	Resistance to internal hydraulic pressure[2] at 110 °C Stress is accordance with the long term strength data			NEN-EN-ISO 1167-1
Influence of heating fitting body	Damage around point of connectiont ≤ 30 % of wall thickness No holes, bubbles or cracks	In consultation with manufacturer			NEN-EN-ISO 580
Resistance to inner water pressure (strength joints)	no leakage	t = 1000 h. T = 95°C Minimum of 3 test pieces			NEN-EN-ISO 1167-1
		p_D	Test pressure[3] (bar)		
			PE-RT Type 1	PE-RT Type 2	
		6 bar	8,7	7,5	
		10 bar	14,4	12,4	

[1] Choice of material is free. The chosen material is listed in the IQC.
[2] Test pieces are blow moulded and are cylindrical shaped
[3] For design stress see sub-paragraph 5.2.2

Par.5.2.5.2 Table 7, 8, 9,10 en 11

Table 7 - Calculated maximum value of S (Scalc, max)

design pressure (p_D)	**Application class 5**	
	$S_{calc\ max.}$ [1)]	
	PE-RT Type 1	PE-RT Type 2
6 bar	4,0	4,8
10 bar	2,4	2,9
1) The values are rounded to the nearest decimal. The maximum allowed Scalc,max = 6,3		

Table 8 – Dimensions of the pipes for dimension group A (dimensions according to ISO 4065 and applicable for all classes within the application conditions)

Dimensions in millimeters

Nominal size DN/OD	**Nominal outside diameter**	**Mean outside diameter**		Pipe series S 5	S 4	S 3,2	S 2,5	S 2,0	**Absolute e_{min} PE-RT** [1)]			
				Wall thickness (incl. barrier layer)					**PE-RT type 1**		**PE-RT type 2**	
	d_n	$d_{em,min}$	$d_{em,max}$	e_{min} en e_n					p_D 6 bar	p_D 10 bar	p_D 6 bar	p_D 10 bar
10	10	10	10,3	0,9	1,1	1,4	1,7	2,0	1,2	1,8	1,0	1.5
12	12	12	12,3	1,1	1,4	1,7	2,0	2,4	1,4	2,1	1,2	1,8
14	14	14	14,3	1,3	1,6	1,9	2,3	2,8	1,6	2,5	1,4	2,1
16	16	16	16,3	1,5	1,8	2,2	2,7	3,2	1,8	2,8	1,6	2,4
20	20	20	20,3	1,9	2,3	2,8	3,4	4,0	2,3	3,5	1,9	3,0
25	25	25	25,3	2,3	2,8	3,5	4,2	5,0	2,8	4,4	2,4	3,7
32	32	32	32,3	2,9	3,6	4,4	5,4	6,4	3,6	5,6	3,1	4,8
1) Absolute calculated minimum wall thickness of the PE-RT material with a minimum of 1.0 mm												

Table 9 – Dimensions of the pipes for dimension group B1 (dimensions based on copper sizes and applicable for all classes within the application conditions)

Dimensions in millimeters

Nominal size DN/OD	**Nominal outside diameter**	**Mean outside diameter**		**Wall thickness (incl. barrier layer)**		**S_{calc}**	**Absolute e_{min} PE-RT [1]**			
							PE-RT type 1		**PE-RT type 2**	
	d_n	$d_{em,min}$	$d_{em,max}$	e_n	e_{min}		p_D 6 bar	p_D 10 bar	p_D 6 bar	p_D 10 bar
10	10	9,9	10,2	1,5	1,5	2,8	1,2	- [2]	1,0	- [2]
				1,8	1,7	2,4	1,2	- [2]	1,0	1,5
12	12	11,9	12,2	1,5	1,5	3,4	1,4	- [2]	1,2	- [2]
				2,0	1,9	2,6	1,4	- [2]	1,2	1,8
15	15	14,9	15,2	1,5	1,5	4,4	- [2]	- [2]	- [2]	- [2]
				2,5	2,4	2,6	1,7	- [2]	1,5	2,3
18	18	17,9	18,2	1,7	1,7	4,8	- [2]	- [2]	[2]	- [2]
				2,5	2,4	3,2	2,0	- [2]	1,7	- [2]
22	22	21,9	22,2	2,0	2,0	5	- [2]	- [2]	- [2]	- [2]
				3,0	2,9	3,3	2,5	- [2]	2,1	- [2]
28	28	27,9	28,2	2,6	2,6	4,9	- [2]	- [2]	- [2]	- [2]
				4,0	3,9	3,1	3,2	- [2]	2,7	- [2]

[1] Absolute calculated minimum wall thickness of PE-RT material with a minimum of 1.0 mm

[2] For a 10 bar system this wall thickness is not permitted due to the fact that the required wall thickness is larger than the nominal wall thickness.

Table 10 – Dimensions of the pipes for dimension group B2 (dimensions based on Irish copper sizes ISO 4065 and applicable for all classes within the application conditions)

Dimensions in millimeters

Nominal size DN/OD	**Nominal outside diameter**	**Mean outside diameter**		**Wall thickness (incl. barrier layer)**	**S_{calc}**	**Absolute e_{min} PE-RT [1]**			
						PE-RT type 1		**PE-RT type 2**	
	d_n	$d_{em,min}$	$d_{em,max}$	e_{min}		p_D 6 bar	p_D 10 bar	p_D 6 bar	p_D 10 bar
14,7	14,7	14,63	14,74	1,6	4,1	- [2]	- [2]	1,4	- [2]
21	21	20,98	21,09	2,05	4,6	- [2]	- [2]	2,0	- [2]
27,4	27,4	27,33	27,44	2,6	4,8	- [2]	- [2]	- [2]	- [2]
34	34	34,08	34,19	3,15	4,9	- [2]	- [2]	- [2]	- [2]

[1] Absolute calculated minimum wall thickness of PE-RT material with a minimum of 1.0 mm

[2] For a 6 and/or 10 bar system this wall thickness is not permitted due to the fact that the required wall thickness is larger than the nominal wall thickness.

Table 11 – Dimensions of the pipes for dimension group C – heating systems

Dimensions in millimeters

Nominal size DN/OD	**Nominal outside diameter**	**Mean outside diameter**		**Wall thickness (incl. barrier layer)**	**S_{calc}**	**Absolute e_{min} PE-RT [1)]**			
						PE-RT type 1		**PE-RT type 2**	
	d_n	$d_{em,min}$	$d_{em,max}$	e_{min}		p_D 6 bar	p_D 10 bar	p_D 6 bar	p_D 10 bar
12	12	12	12,3	2,0	2,5	1,4	- [2)]	1,2	1,8
14	14	14	14,3	2,0	3,0	1,6	- [2)]	1,4	- [2)]
15	15	15	15,3	2,0	3,2	1,7	- [2)]	1,5	- [2)]
16	16	16	16,3	2,0	3,5	1,8	- [2)]	1,6	- [2)]
17	17	17	17,3	2,0	3,8	1,9	- [2)]	1,7	- [2)]
18	18	18	18,3	2,0	4,0	- [2)]	- [2)]	1,8	- [2)]
20	20	20	20,3	2,0	4,5	- [2)]	- [2)]	1,9	- [2)]

[1)] Absolute calculated minimum wall thickness of PE-RT material with a minimum of 1.0 mm

[2)] For a 6 and/or 10 bar system this wall thickness is not permitted due to the fact that the required wall thickness is larger than the nominal wall thickness.

5.2.6 Certification mark

The following marks and indications must be provided on each product and product packaging in a clear, legible and indelible way:

- KOMO (or KOMO® word mark) + class 5 / 6 or 10 bar;
- certificate number of the accompanying technical approval(system)certificate;
- manufacturer's name, trade name, system name or logo;
- material identification : PE-RT (type 1 or 2);
- construction pipe: PE-RT/EVOH of PE-RT/EVOH/PE-RT
- nominal outside diameter and nominal wall thickness in mm.
- production code

9. List of documents

9.1 Requirements under public law

There are no requirements under public law applicable.

9.2 Normative documents

The following documents are changed in relation to the date of issue:

ISO 4065:2018 en	Thermoplastic pipes - Universal wall thickness table
NEN-EN 10283:2019 en	Corrosion resistant steel castings
NEN-EN-ISO 11357-3: 2018 en	Plastics - Differential scanning calorimetry (DSC) - Part 3: Determination of temperature and enthalpy of melting and crystallization
ISO 11922-1: 2018 en	Thermoplastics pipes for the conveyance of fluids - Dimensions and tolerances - Part1: Metric series

The following documents are added:

NEN-EN-ISO 13056: 2018 en	Plastics piping systems - Systems for hot and cold water - Test method for leaktightness under vacuum
NEN-EN-ISO 19893: 2018 en	Plastics piping systems - Thermoplastics pipes and fittings for hot and cold water - Test method for the resistance of mounted assemblies to temperature cycling

The following documents are removed:

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

Remark:

Every year it is checked whether the normative documents are still up-to-date Changes to the applicable normative documents are published on the services page on the website of the certification institute that has drawn up this assessment guideline.

Table of contents

1	**Introduction**	**3**
1.1	General	3
1.2	Field of application	3
1.3	Relation to European Regulation constructionproducts (CPR, EU 305/2011)	3
1.4	Acceptance of test reports delivered by the supplier	4
1.5	(Technical approval-with-)product certificate	4
2	**Terminology**	**5**
2.1	General definitions	5
2.2	Geometrical terminology and definitions	5
2.3	Terms and definitions related to service conditions	7
2.4	Symbols	9
2.5	Abbreviations	9
3	**Procedure for obtaining a (technical approval-with-)product certificate**	**10**
3.1	Initial investigation	10
3.2	Issue of the (technical approval-with-)product certificate	10
4	**Performances in the application**	**11**
4.1	General	11
4.2	Performance requirements	11
4.3	Determination methods piping system	11
5	**Product requirements and determination methods**	**13**
5.1	Fittings	13
5.2	Pipes	15
5.3	Corrugated pipes	20
6	**Quality system requirements**	**23**
6.1	General	23
6.2	Manager of the quality system	23
6.3	Internal quality control/quality plan	23
6.4	Management of laboratory- and measure apparatus	23
6.5	Procedures and work instructions	23
6.6	Other requirements imposed on the quality system	23
7	**Summary of tests and inspections**	**24**
7.1	Testmatrix	24
7.2	Evaluation of the quality system	25

8	**Requirements imposed on the certification body**	**26**
8.1	General	26
8.2	Certification staff	26
8.3	Report initial tests	27
8.4	Decision with regard to the issue of the certificate	27
8.5	Nature and frequency of external inspections	28
8.6	Report to the Board of Experts	28
8.7	Interpretation of requirements	28
8.8	Sanction policy	28
9	**List of mentioned documents**	**29**
9.1	Norms/ normative documents:	29
I	**Example IQC-scheme for product manufacturer**	**31**
II	**Example IQC-scheme for system holders**	**36**
III	**Corrugated pipes - Compression testing**	**42**

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 a license agreement with Stichting KOMO, when dealing with applications for the issue or maintenance of a (technical approval-with-)product certificate for Plastics piping systems of PE-RT intended for heating systems: radiator connections.

The technical field of this evaluation guideline is: F2 piping systems.

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 replaces BRL 5607 dated 01 June 2008 and alteration sheet dated 06 June 2012.
(Technical approval-with-)product certificates issued on the basis of that evaluation guideline and the alteration sheet loose their validity at most after one year after binding declaration.

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 applied in piping systems for hot water distribution for radiators connections at a design pressure (= maximum operating pressure) of 6 bar (7 bar absolute or 6 bar overpressure), under the conditions mentioned in table 1.

Remark:
Each pressure mentioned in this evaluation guideline is defined as overpressure.
(So, with "6 bar" a "6 bar overpressure" is meant).

Table 1 – Temperature profile during 50 years

	Temperature [ºC]	Lifetime	Overall service coefficient
T_{cold}	20	14 years	1,25
T_{design}	60 + 80	25 years + 10 years	1,5
T_{max}	90	1 year	1,3
$T_{malfunction}$	100	100 hours	1,0
Remark: the mentioned temperature profile is in accordance with class 5 of ISO 10508.			

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.

Explanation
NEN-EN-ISO/IEC 17021-1 is published on 1 July 2015 and will replace NEN-EN-ISO/IEC 17021. A transition period of 2 years is in place.

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 (Technical approval-with-)product 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 color, which are a part of the system, are listed, which comply to the requirements as stated in chapter 4, 5 en 6 of this evaluation guideline.
- Product certificate for the fittings and/ or pipes for the technical approval-with-product certificate in question. In the product certificate products with their dimensions, material type and color, are listed which comply to the requirements as listed in chapter 5 and 6 of this evaluation guideline.

On the website of the KOMO foundation (www.komo.nl) the models (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.

2 Terminology

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 IQC-scheme
A description of the quality inspections carried out by the manufacturer as part of this quality system.

2.1.2 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 due to the possible bends.

2.1.3 Manifolds
An apparatus by which an incoming water flow is divided (adjustable) over several outlets.

2.1.4 Mechanical joints
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.

2.1.5 Piping system
The total of pipes, protection pipes, fittings, bends, expansion pieces, valves and other piping components.

2.1.6 Rigid piping system
A piping system in which possible bends in the pipe has to be made by mechanical means.

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

2.2 Geometrical terminology 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 millimeters;
e_n = the nominal wall thickness expressed in millimeters.

2.2.2 Inside diameter (at any point) (d_i)
Measured inside diameter at any point, rounded up to the nearest 0,1 mm.

2.2.3 *Maximum calculated pipe value ($S_{calc,max}$)*

The maximum value of the calculated S value for a specific application class.
The lowest value of:

$$\sigma_D / p_D \quad \text{or} \quad \sigma_{20} / (p_D = 1\,\text{MPa})$$

In which:
σ_D = the design pressure after 50 years in MP applicable for a class 5 material.
σ_{20} = the design pressure at 20 °C after 50 years in MPa
P_D = the design pressure in MPa

2.2.4 *Maximum mean outside diameter ($d_{em,\ max}$)*

Maximum value for the mean outside diameter as specified for a given nominal size.

2.2.5 *Maximum wall thickness (e_{max})*

Maximum wall thickness around the circumference of a component, as specified.

2.2.6 *Minimum mean outside diameter ($d_{em,\ min}$)*

Minimum value for the mean outside diameter as specified for a given nominal size.

2.2.7 *Mean outside diameter (d_{em})*

Measured outside diameter through its cross section at any point of a pipe or spigot end of a fitting in any cross section divided by π (=3,142), rounded up to the nearest 0,1 mm.

2.2.8 *Minimum wall thickness (e_{min})*

Minimum wall thickness around the circumference of a component, as specified.

2.2.9 *Nominal outside diameter (d_n)*

Specified outside diameter, in millimeters, assigned to a nomial size DN/OD.

2.2.10 *Nominal size (DN)*

Numerical designation of the size of a component, which is a convenient round number, approximately equal to the manufacturing dimensions in millimeters (mm).

2.2.11 *Nominal wall thickness (e_n)*

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

2.2.12 *Outside diameter (at any point) (d_e)*

Measured outside diameter through its cross section at any point of a pipe or spigot end of a fitting, rounded up to the nearest 0,1 mm.

2.2.13 *Out-of-roundness (ovality)*

Difference between the measured maximum outside diameter and the measured minimum outside diameter in the same cross-sectional plane of a pipe or spigot end of a fitting, or the difference between the measured maximum inside diameter and the measured minimum inside diameter in the same cross-sectional plane of a socket.

2.2.14 *Pipe series (S)*

Dimensionless number for pipe designation conforming to ISO 4065.

2.2.15 *Tolerance*

Permitted variation of the specified value of a parameter, expressed as the difference between the permitted maximum and the permitted minimum value.

2.2.16 Wall thickness (at any point) (e)

Measured wall thickness at any point around the circumference of a component, rounded up to the nearest 0,1 mm.

2.3 Terms and definitions related to service conditions

2.3.1 Cold-water temperature (T_{cold})

The temperature of the cold water with a maximum of 25 °C. For the calculation of the design pressure applications a water temperature of 20 °C is issued.

2.3.2 Design pressure (p_D).

The allowable pressure in the piping system that, during continuous use, during 50 years may occur .

2.3.3 Hydrostatic tension σ

Stress in the circumferences direction of the pipe wall caused by internal water pressure. This stress is deduced from the internal pressure according to the following formula:

$$\sigma = p \times \frac{(d_{em} - e_{\min})}{20 \times e_{\min}}$$

In which:

σ = the stress 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;

e_{min} = de minimum wall thickness of the pipe in mm.

2.3.4 Lifetime

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

2.3.5 LPL

The lower confidence level. A statistical unit representing the point above which 97,5 % of all values are found.

2.3.6 Maximum design temperature (T_{max})

Highest temperature of the water to be conveyed depending on the service conditions for which the system has been designed for, occurring for a short period only.

2.3.7 Malfunction temperature (T_{mal})

Highest temperature of the water to be conveyed depending on unintended conditions (i.e. exceeding of control limits) for which the system has been designed for, occurring for short periods only (max. 100 hours in 50 years).

2.3.8 Operating temperature ($T_{operation}$)

The temperature of the water to be conveyed depending on the service conditions for which the system has been designed for.

2.3.9 Overall service (design)coefficient (C)

Overall coefficient with a value greater than or equal to 1,, which takes into consideration service conditions as well as properties of the components of a piping system other than those represented in the lower confidence limit, LPL.

2.3.10 PE-RT Type 1

Material indication exclusively applicable for this BRL. This indication describes PE-RT materials according to ISO 10508 class 5, determined in accordance with paragraph 4.2.2, with a sigma of at least 2,4 MPa.

2.3.11 PE-RT Type 2

Material indication exclusively applicable for this BRL. This indication describes PE-RT materials according to ISO 10508 class 5, determined in accordance with paragraph 4.2.2, with a sigma of at least 2,9 MPa

2.3.12 Reference line

By a group of experts determined minimum long-term strength hoopstress for a specific material.

2.3.13 Temperature profile

The most frequently appearing temperatures that during 50 years occur during a certain time.

2.3.14 σ_D

The design stress in MPa, applicable for a class 3 material with a temperature profile according to table 1.

2.3.15 σ_T

The stress in MPa, applied to a test piece for a certain temperature and time.

2.3.16 σ_{LPL}

An unit expressed in wall stress, that represents the value of the 97,5% lower confidence level of the predicted stress for a single value at a temperature T and a time t.

2.3.17 σ_{LTHS}

An unit expressed in wall stress, that represents the value of 50% lower confidence interval of the predicted stress for a single value at a temperature T and a time t.

2.4 Symbols

C	service (design) coefficient
d_e	outside diameter (at any point)
d_{em}	mean outside diameter
$d_{em,min}$	minimum mean outside diameter
$d_{em,max}$	maximum mean outside diameter
d_n	nominal diameter
e	wall thickness at any point
e_{max}	maximum wall thickness at any point
e_{min}	minimum wall thickness at any point
e_n	nominal wall thickness
F	force
p	pressure
p_D	design pressure
S_{calc}	calculated S-value
$S_{calc,max}$	maximum calculated S-value
T	temperature
T_{cold}	cold-water temperature
$T_{operation}$	operating temperature
T_{mal}	malfunction temperature
T_{max}	maximum design temperature
t	time
σ	hydrostatic stress
σ_{cold}	design stress at 20 °C
σ_D	design stress
σ_{DF}	design stress of the plastics fitting material
σ_{DP}	design stress of the plastics pipe material
σ_F	hydrostatic stress value of the plastics fitting material
σ_P	hydrostatic stress value of the plastics pipe material
σ_{LPL}	lower confidence interval of the long-term strength
σ_{LTHS}	hydrostatische spanning bij de betrouwbaarheidsinterval van 50%

2.5 Abbreviations

CI	Certification Institute
CPR	Construction Products Regulation
DN	nominal size
DN/OD	nominal size related to outside diameter
EVOH	Ethyleen-vinlyalcohol
LPL	lower confidence interval
PE-RT	polyethylene raised temperature
S	S-value
MFR	melt flow rate

3 Procedure for obtaining a (technical approval-with-)product certificate

3.1 Initial investigation

3.1.1 Technical approval-with-product certificate

For the purpose of obtaining the KOMO technical approval-with-product certificate the certification institute will perform an investigation. The certification institute shall determine that the applicant is able to continuously manufacture products which meet the requirements in this guideline. The initial investigations consist of:

- Assessment if the internal quality system of the applicant meets the requirements of chapter 6 of this guideline.
- Determination and assessment of the performance in the application of the specified piping system and ascertain if the requirements of chapter 4 of this guideline are met.
- Assessment of the by the applicant provided or to provide documents in relation to the internal quality assurance to check if the with the products assembled piping system meets the performance requirements as laid down in this guideline.
- Assessment of the processing instructions and the terms of the application.

3.1.2 Product certificate

For the purpose of obtaining the KOMO product certificate the certification institute will perform an investigation. The certification institute shall determine that the applicant is able to continuously manufacture products which meet the requirements in this guideline. The initial investigations consist of:

- Assessment if the internal quality system of the applicant meets the requirements of chapter 6 of this guideline.
- Inspection of the production and the finished product to determine if the product meets the requirements in chapter 5 of this guideline.
- Determination of the product characteristics (of the constituent products) as laid down in the guideline.

3.2 Issue of the (technical approval-with-)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 certificate can be issued or whether additional information and/or investigations are required in order to be able to issue the (technical approval-with-)product certificate.

4 Performances in the application

4.1 General

In this chapter the performance requirements imposed on the plastics piping systems of PE-RT intended for heating installations: radiator connections in the application are included, as well as the determination methods in order to be able to determine whether the requirements in the application are fulfilled. 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.

4.2 Performance requirements

- The system needs to be adequately resistant to oxygen permeability
- All joints need to be leak proof and sufficiently tight to endure external influences.
- All parts of the system are required to be designed to have a life expectancy of 50 years at a temperature profile in accordance to class 5 from NEN-ISO 10508, at an operating pressure of 6 bar absolute.

4.3 Determination methods piping system

4.3.1 General

The joints in the piping system have to be tested with regard to their proper functioning in accordance to table 2. In this chapter all joint tests required for the joint system are included. The combination of a (possible) rubber seal, pipe, (possible) supporting insert and clamp construction in the fitting have to be tested with regard to the aspects as mentioned in table 2.

4.3.2 Tightness and strength of the joints

After testing in accordance with table 2, the piping system is sufficiently watertight and the pipe ends shall show no damage.
If not otherwise stated, the testing temperature is (23 ± 2) °C.

4.3.3 Installation instructions

The supplier shall provide installation instructions. The instruction shall be in the Dutch language and must contain specific information for construction of the joints. Also instructions must be given with regard to storage, transport and processing temperature.

Table 2 - Tightness and strength of the pipe joints

Aspect	Requirement	Test parameters		Test method
Resistance of mounted assemblies to temperature cycling	no leakage	5000 cycli T_{max} = (95 ± 2) °C T_{min} = (20 ± 2) °C t_{cyclus}= 30 min [1]. p_D (bar) Pre-stress 2,2 MPa One test piece		NEN-EN 12293
Resistance to pull-out under constant longitudinal force	No separation of pipe and fitting no scratches or breakage within the distance d (= diameter of the pipe) on the pipe and fitting	t = (60 ± 1) min. Three test pieces F = 1,5 x π/4 x D_n^2 x 1 (N) D_n in mm		NEN-EN-ISO 3501
Leaktightness under vacuum	Δp ≤ 0,05 bar	t = (60 ± 1) min. Three test pieces p= -0,8 bar		NEN-EN 12294
Leaktightness under internal pressure of assemblies subjected to bending (∅ >32 mm)	no leakage	t = (60±1) min. Three test pieces		NEN-EN-ISO 3503
		Test pressure (bar)		
		PE-RT Type 1	PE-RT Type 2	
		24,8	25,0	
Resistance to inner water pressure (strength joints)	geen lekkage	t = 1000 h. T = 95°C Minimum of 3 testpieces		NEN-EN-ISO 1167-1
		Test pressure (bar) [2]		
		PE-RT Type 1	PE-RT Type 2	
		8,7	7,5	
Oxygen permeability [3]	≤ 1,8 mg O_2/m².dag	20 meters of pipe with 4 fittings 80 °C		NEN-ISO 17455

[1] t_{cyclus}= t_{Tmax} + t_{Tmin} (= 15^{+1}_{0} + 15^{+1}_{0} = 30^{+2}_{0}) minutes. Total time = 2500 hours)

[2] For design stress see clause 4.5.2.

[3] Because the required value is expressed in a surface area unit, it is sufficient to measure the smallest diameter of the diameter series of the manufacturer (as long as the same wall thickness of the barrier layer applies to all diameters). For the purpose of inspection also other diameters can be tested

5 Product requirements and determination methods

In this chapter the product requirements are listed which de compounded products needs to meet, as well as the testing methods to determine these are met. 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.

5.1 Fittings

Distributers (fittings with more than 2 outlets) can be part of a piping system, in which case have to comply to the demands stated in this chapter.

5.1.1 Plastic fittings

The plastic fittings have to fulfil the requirements as listed in tabel 3.

Tabel 3 – Requirements for plastic fittings

Aspect	Requirement	Test parameter		Test method
Material fitting body	relevant product standard for the plastic used	IQC [1)]		Information producer
Long-term strength material fitting body	≥ design stress (σ_D) according to the relevant product standard of the plastic at class 5	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 the aid of NEN-EN-ISO 9080
Appearance	Smooth, without any irregularities	Flawlessness		Visual assement
Dimensions	Specification producer	Construction drawings		NEN-EN-ISO 3126
Rubber	BRL 2013	BRL 2013		BRL 2013
Degree of cross linking (for PE-X fittings)	PE-Xa ≥ 70% PE-Xb ≥ 65% PE-Xc ≥ 60% PE-Xd ≥ 60%	Degree of cross linking		NEN-EN-ISO 10147
MFR (for PPR fittings)	≤ 30% difference with respect to granulated material	Mass 2,16 kg Temperature 230 °C Test period 10 min		NEN-EN-ISO 1133-1
MFR (for PB fittings)	≤ 30% difference with respect to granulated material	Mass 2,16 kg Temperature 190 °C Test period 10 min		NEN-EN-ISO 1133-1
Resistance to internal pressure : Thermal stability material fitting body	Test time > 8760 h	Resistance to internal hydraulic pressure [2)] At 110 °C Stress is accordance with the long term strength data		NEN-EN-ISO 1167-1
Influence of heating fitting body	Damage around point of connection ≤ 30 % of wall thickness No holes, bubbles or cracks	In consultation with manufacturer		NEN-EN-ISO 580
Resistance to inner water pressure (strength joints)	no leakage	t = 1000 h / T = 95°C Minimum of 3 test pieces Test pressure (bar) [3)]		NEN-EN-ISO 1167-1
		PE-RT Type 1	PE-RT Type 2	
		8,7	7,5	

[1)] Choice of material is free. The chosen material is listed in the IQC.
[2)] Test pieces are blow moulded and are cylindrical shaped
[3)] For stress design see sub-paragraph 5.2.2

5.1.2 Metal fittings

The metal mechanical fittings must fulfil the requirements of table 4.

Table 4 – requirements for metal fittings

Aspect	Eis	Test parameter	Test methode
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
Resistance to inner water pressure (strength fitting body	No cracks	**Brass:** NEN-EN1254-3 par. 5.1 NEN-EN 1254-6 Par. 5.1.4 NEN-EN 1254-8 Par.5.1.1 **Stainless steel:** 25 bar at (23 + 2) °C during 48 hours[2)]	NEN-EN-ISO 1167-1
Brass Resistance to stress corrosion	No cracks	PH 9,5	NEN-ISO 6957
Stainless steel: Resistance to intercrystalline 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.			

5.1.3 Certification mark

The following marks and indications must be provided on each product and product packaging in a clear, legible and indelible way:

The fittings shall be provided with at least the following marks;

- KOMO of KOMO® word mark (if not possible KOMO on only the smallest packaging);
- manufacturer's name, trade name or logo;
- nominal outside diameter in mm of the connecting pipe;
- production code

The smallest packaging unit of the fittings must be provided with at least the following information:

- KOMO (or KOMO® word mark);
- certificate number of the accompanying technical approval(system)certificate, in accordance with the marking of the connecting pipe;
- manufacturer's name, trade name, system name or logo;
- nominal outside diameter and nominal wall thickness in mm of the connecting pipe;
- material identification in case the fitting body is made of plastic.

5.2 Pipes

5.2.1 Introduction

In this chapter the requirements which the pipes have to meet as well as the test methods to determent this, are listed.

5.2.2 Classification of the PE-RT material

The PE-RT materials must fulfill the requirements according to NEN-EN-ISO 22391-2.

The calculated values for σ_D must be higher than or equal to the values in table 5.

Tabel 5 – minimum required wall stress for class 5

Type PE-RT	Ontwerpspanning σ_D (N/mm^2)
1	2,38
2	2,88

5.2.3 Construction of the pipe

The pipe can be composed of 3 or 5 layers. From inside to outside the following applies:
3-layer pipe:
A PE-RT inner layer, an adhesive layer, an oxygen barrier layer.
4-layer pipe:
An extra outer layer of a non-load bearing material (for example PE/adhesive) on the 3-layer pipe is possible.
5-layer pipe:

- A PE-RT inner layer, an adhesive layer, an oxygen barrier layer, an adhesive layer, a PE-RT outer layer.
  The wall thickness of the inner layer shall be at least 0,4 mm.
  The total of the wall thickness of both PE-RT layers must comply with the appropriate requirement according to table 6.
- A PE-RT inner layer, an adhesive layer, an oxygen barrier layer, an adhesive layer an outer layer of a non-stress bearing material (i.e. PE),
  The total of the wall thickness of the PE-RT inner layer must comply with the appropriate requirement according to table 6.

Remark: for the barrier layer currently only EVOH is used.

5.2.4 Plastics barrier layer

The plastics barrier layer shall fulfil the following preconditions:

- The mechanical characteristics of the pipe may not be adversely affected by this layer.
- Information concerning the wall thickness of the layer and its tolerances, as well as the type and the supplier of the plastics barrier layer, shall be a part of the certification agreement.

5.2.5 Requirements for the pipes

The chosen material for the pipe is listed in the IQC.

5.2.5.1 *Mechanical requirements for the pipe*

For the different layers and the complete pipe the requirements according to table 6 apply.

Tabel 6 – requirements and test methods for PE-RT pipes

Aspect	Requirement	Test parameter		Test method
Appearance	Smooth without any flaws	flawlesness		Visual inspection
Dimensions of different layers	Information manufacturer	Construction drawings		NEN-EN-ISO 3126
MFR	≤ 30 % (In accordance with the value of the plastic granule)	Mass 2,16 kg Temperature 190 °C Test period 10 min		NEN-EN-ISO 1133-1
Resistance to internal pressure [1] PE-RT Type 1	Test time (hour)	T (°C)	σ (MPa)	NEN-EN-ISO 1167-1
	≥ 1	20	9,9	
	≥ 22	95	3,8	
	≥ 165	95	3,6	
	≥ 1000	95	3,4	
Thermal stability PE-RT Type 1	Test time (hour)	T (°C)	σ (MPa)	
	≥ 8760	110	1,9	
Resistance to internal pressure [1] PE-RT Type 2	Test time (hour)	T (°C)	σ (MPa)	NEN-EN-ISO 1167-1
	≥ 1	20	10,8	
	≥ 22	95	3,9	
	≥ 165	95	3,7	
	≥ 1000	95	3,6	
Thermal stability PE-RT Type 2	Test time (hour)	T (°C)	σ (MPa)	
	≥ 8760	110	2,3	
Longitudinal reversion of complete pipe	≤ 2 %	Change in length 1 hour at 110°C		NEN-EN-ISO 2505
Oxygen permeability [2]	≤ 1,8 mg O_2/m².day	80 °C		NEN-ISO 17455
Melting temperature adhesive	≥ 120 °C	DSC method		NEN-EN-ISO 11357-3

[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] Because the required value is expressed in a surface area unit, it is sufficient to measure the smallest diameter of the diameter series of the manufacturer (as long as the same wall thickness of the barrier layer applies to all diameters). However for the purpose of inspection also other diameters can be tested

5.2.5.2 *Dimensions*

Each class, nominal size and minimum wall thickness must be chosen in such a way according table 8, 9, 10, 11 and 12 that the corresponding S-series or the S_{calc} is equal or smaller than the $S_{calc, max}$ as indicated in table 7.

Table 7 – Calculated maximum value of S ($S_{calc, max}$)

Design pressure	**Application class 5**	
	$S_{calc\ max.}$ [1)]	
	PE-RT Type 1	PE-RT Type 2
6 bar	4,0	4,8
[1)] The values are rounded to the nearest decimals.		

Table 8 – Dimensions of the pipes for dimension group A (dimensions according to ISO 4065 and corresponding for all classes within the application conditions

Dimensions in millimeters

Nominal size DN/OD	**Nominal outside diameter**	**Mean outside diameter**		Pipe series				**Absolute e_{min} PE-RT [1)]**	
				S 6,3	S 5	S 4	S 3,2		
				Wall thickness (incl. barrier layer)					
	d_n	$d_{em,min}$	$d_{em,max}$	e_{min} and e_n				**PE-RT type 1**	**PE-RT type 2**
10	10	10	10,3	0,8	1,0	1,1	1,4	1,2	1,0
12	12	12	12,3	0,9	1,1	1,4	1,7	1,4	1,2
14	14	14	14,3	1,1	1,3	1,6	1,9	1,6	1,4
15	15	15	15,3	1,1	1,4	1,7	2,1	1,7	1,5
16	16	16	16,3	1,3	1,5	1,8	2,2	1,8	1,6
20	20	20	20,3	1,4	1,9	2,3	2,8	2,3	1,9
25	25	25	25,3	1,8	2,3	2,8	3,5	2,8	2,4
32	32	32	32,3	2,3	2,9	3,6	4,4	3,6	3,1
[1)] Absolute calculated minimum wall thickness of the PE-RT material with a minimum of 1.0 mm.									

Table 9 – Dimensions of the pipes for dimension group B1 (dimensions based on copper sizes and applicable for all classes within the application conditions)

Dimensions in millimeters

Nominal size DN/OD	**Nominal outside diameter**	**Mean outside diameter**		**Wall thickness (incl. barrier layer)**		**S_{calc}**	**Absolute e_{min} PE-RT [1)]**	
	d_n	$d_{em,min}$	$d_{em,max}$	e_n	e_{min}		**PE-RT type 1**	**PE-RT type 2**
10	10	9,9	10,2	1,5	1,5	2,8	1,2	1,0
				1,8	1,7	2,4	1,2	1,0
12	12	11,9	12,2	1,5	1,5	3,4	1,4	1,2
				2,0	1,9	2,6	1,4	1,2
15	15	14,9	15,2	1,5	1,5	4,4	- [2)]	- [2)]
				2,5	2,4	2,6	1,7	1,5
18	18	17,9	18,2	1,7	1,7	4,8	- [2)]	[2)]
				2,5	2,4	3,2	2,0	1,7
22	22	21,9	22,2	2,0	2,0	5	- [2)]	- [2)]
				3,0	2,9	3,3	2,5	2,1
28	28	27,9	28,2	2,6	2,6	4,9	- [2)]	- [2)]
				4,0	3,9	3,1	3,2	2,7

[1)] Absolute calculated minimum wall thickness of the PE-RT material with a minimum of 1.0 mm.
[2)] For a 6 bar system this material is not allowed because the minimum required wall thickness is larger than the nominal wall thickness.

Table 10 – Dimensions of the pipes for dimension group B2 (dimension based on Irish copper sizes and applicable for all classes within the application conditions)

Dimensions in millimeters

Nominal size DN/OD	**Nominal outside diameter**	**Mean Outside diameter**		**Wall thickness (incl. barrier layer)**	**S_{calc}**	**Absolute e_{min} PE-RT [1)]**	
	d_n	$d_{em,min}$	$d_{em,max}$	e_{min}		**PE-RT type 1**	**PE-RT type 2**
14,7	14,7	14,63	14,74	1,6	4,1	1,7 [2)]	1,4
21	21	20,98	21,09	2,05	4,6	2,4 [2)]	2,0
27,4	27,4	27,33	27,44	2,6	4,8	3,1 [2)]	2,6 [2)]
34	34	34,08	34,19	3,15	4,9	3,8 [2)]	3,3 [2)]

[1)] Absolute calculated minimum wall thickness of the PE-RT material with a minimum of 1.0 mm.
[2)] For a 6 bar system this material is not allowed because the minimum required wall thickness is larger than the nominal wall thickness.

Table 11 – Dimensions of the pipes for dimension group C – heating systems

Dimensions in millimeters

Nominal size DN/OD	**Nominal outside diameter**	**Mean outside diameter**		**Wall thickness (incl. barrier layer)**	**S_{calc}**	**Absolute e_{min} PE-RT [1)]**	
	d_n	$d_{em,min}$	$d_{em,max}$	e_{min}		**PE-RT type 1**	**PE-RT type 2**
12	12	12	12,3	2,0	2,5	1,4	1,2
14	14	14	14,3	2,0	3,0	1,6	1,4
15	15	15	15,3	2,0	3,2	1,7	1,5
16	16	16	16,3	2,0	3,5	1,8	1,6
17	17	17	17,3	2,0	3,8	1,9	1,7
18	18	18	18,3	2,0	4,0	2,0 [2)]	1,8
20	20	20	20,3	2,0	4,5	2,3 [2)]	1,9

[1)] Absolute calculated minimum wall thickness of the PE-RT material with a minimum of 1.0 mm.
[2)] For a 6 bar system this material is not allowed because the minimum required wall thickness is larger than the nominal wall thickness.

Table 12 – Tolerances for the wall thickness

Dimensions in millimeters

Minimum wall thickness e_{min}		**Tolerance [1)]** X	**Minimum wall thickness** e_{min}		**Tolerance [1)]** X
>	≤		>	≤	
1	2	0,3	4	5	0,6
2	3	0,4	5	6	0,7
3	4	0,5	6	7	0,8

[1)] The tolerance is defined as (+X/0 mm) in which X is the value of the tolerance as mentioned in this table . The permitted tolerance corresponds to level 5 of ISO 11922-1.

5.2.6 Certification mark

The following marks and indications must be provided on each product and product packaging in a clear, legible and indelible way:

- KOMO (or KOMO® word mark) + class 5 / 6 bar;
- certificate number of the accompanying technical approval(system)certificate;
- manufacturer's name, trade name, system name or logo;
- material identification : PE-RT (type 1 or 2);
- construction pipe: PE-RT/EVOH of PE-RT/EVOH/PE-RT
- nominal outside diameter and nominal wall thickness in mm.
- production code.

5.3 Corrugated pipes

5.3.1 Introduction

Corrugated pipes are compulsory for PE-RT pipe diameters up to and including 25 mm. The corrugated pipes can be part of the system as desired for the larger diameters. The requirements for the corrugated pipes are included in table 13.

Table 13 – requirements for corrugated pipes

Aspect	**Requirements**	**Test parameter**	**Test method**
Material composition	Specification producer	IQC	Specification producer
Appearance	Regular profile. Inner and outer surface is smooth and free from holes, bubbles, contaminations or other flaws.	Flawlessnes	Visual inspection
Mass per length	Specification producer	Weight per metre	paragraph 5.3.2.3
Dimensions	Specification producer	Technical drawing	NEN-EN-ISO 3126
Resistance to compression	Compression after 5 minutes not more than 22 %. After neutralization of the load, the outside diameter must be at least 85 % of the initial value	Change in diameter	paragraph 5.3.2.1
Resistance to impact	10 test pieces => no breakage 1 breakage: repeat the test with twice the number of test pieces. Over total of 30 test pieces => not more than 2 breakages	Impact strength	paragraph 5.3.2.2
Resistance to pull force in radial direction (only with duo pipes [1)])	Pull force > 250N No damage on the protection pipes	Pull force	paragraph 5.3.2.4

[1)] Duo pipes are protection pipes that are connected with a groove connection in the length direction of the pipe. The length of the connection is at least a (50±1) mm tightly jointed connection per 0,5 m pipe.

5.3.2 Additional test methods

5.3.2.1 *Determination of the resistance to compression*
See Annex III.

5.3.2.2 *Determination of the resistance to impact*

Apparatus
For the test an impact apparatus is required provided with a striker with a spherical shaped impact bottom with a radius of 12,5 mm and a V-shaped support block at an angle of 120º. Further, a cooler is required in which the test pieces can be conditioned at a temperature of (0 ± 1) ºC.

Test pieces
For each pipe size to be tested 10 test pieces are required with a length of 100 mm. The test pieces must be conditioned in water or air at a temperature of (0 ± 1) ºC. When refrigerating in water, the cooling time amounts 30 minutes and when cooling off in air, the cooling time amounts 60 minutes.

Procedure
Put the test pieces on the V-shaped support block and let the striker fall in the middle of the test pieces. A test piece must be tested within 10 seconds after it is taken out of the cooler. The applicable test conditions are mentioned in table 14.

Table 14 – Test conditions for corrugated pipes

Nominal outside diameter of the connecting pipe [1])	**Mass striker in g [2])**	**Fall height in mm [3])**
Up to and including 25 mm	250	1000
32 up to and including 50 mm	250	2000
[1)] Meant are the pipes that accompany the corrugated pipes to be tested. [2)] Tolerance: - 0/+ 5 g. [3)] Tolerance: - 0/+ 5 mm.		

5.3.2.3 *Determination of the mass per length*
For the determination of the mass per length three corrugated pipes with a length of approximately 1 m are required. The real length must be determined as accurately as possible. The mass of these pipes must be determined, with the help of a balance, with an accuracy of 0,1 gram.
The arithmetic mean of the three values is qualifying.

5.3.2.4 *Resistance to pull force in radial direction*

Equipment
On a tensile tester two parallel metal pins will be installed. with a diameter identical to the internal diameter of the protection pipe (± 4 mm). The metal pins on the right side can be moved in parallel direction and the necessary force can be measured. During this test the metal pins shall not bend. (see figure 2). During testing the surrounding temperature and the sample temperature must be (23 ± 2)°C.

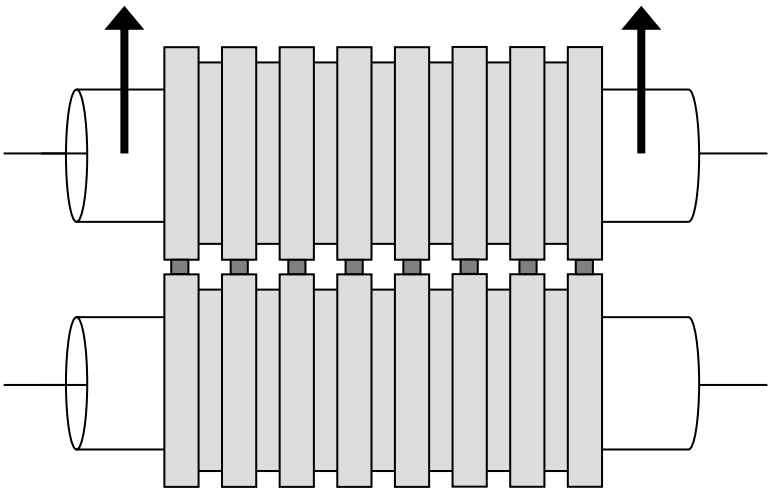

Figure 2 – test model resistance against pull force.

Test pieces
The 5 necessary test pieces must have a length of (50 ± 1) mm. There must be a connection between the 2 corrugated pipes across the entire length.

Method
The test pieces will be applied to the parallel straight metal pins where each pipe section will be placed on a different pin. (see figure 2).

When test pieces are installed the metal pins will be moved parallel in radial direction with a speed of 15 mm/min. During this movement the necessary force shall be recorded.

The test is completed only when both pipe parts are separated entirely from each other. The maximum force (pull-free force) that was necessary to complete the test shall be recorded in Newton. Of the 5 measured test pieces all values shall meet the demands for the pull-free force in radial direction.

5.3.3 Marking

The corrugated pipes shall be provided with the following marks, clearly legible and indelible, at intervals of no more than 2,5 meters:

- KOMO (KOMO® word mark);
- certificate number of the corrugated pipe;
- factory name, tradename or logo.

6 Quality system requirements

6.1 General

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

6.2 Manager of the quality system

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

6.3 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.

6.4 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.

6.5 Procedures and work instructions

The supplier must be able to submit procedures for:

- storage of used materials and readied product;
- 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.

6.6 Other requirements imposed on the quality system

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

7 Summary of tests and inspections

7.1 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 also 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	Par. BRL	Test within the scope of			Change of raw material
		Initial tests	Surveillance by CI after issue of the certificate[1)]		
			Inspection[2)]	Frequency	
System requirements					
Resistance of mounted assemblies to temperature cycling	4.3.1	X			X
Resistance to pull-out under constant longitudinal force		X			
Leaktightness under vacuum		X			
Leaktightness under internal pressure of assemblies subjected to bending		X			
Resistance to internal pressure (strength joints)		X	X	1x year	X
Oxygen permeability		X			X
Installation instructions		X			
Requirements for plastics fittings/ dividers					
Material	5.1.1	X	X	1x year	X
Long-term strength		X	X [3)]	1x year	X
Dimensions		X	X	1x year	X
Rubber		X			X
Degree of cross linking / MFR		X	X	1x year	X
Resistance to inner water pressure (strength fitting body) (see system)		X	X	1x year	X
Appearance		X	X	1x year	X
Resistance to internal pressure: Thermal stability material fitting body		X			X
Influence of heating		X			X
Requirements for metal fittings/ dividers					
Material composition	5.1.2	X	X	1x year	X
Rubber		X			X
Dimensions		X	X	1x year	X
Construction		X			X
Resistance to internal pressure (strength body) see system		X			X
Resistance to stress corrosion		X			X
Resistance to intergranular corrosion		X			X

Description of requirement	Par. BRL	Test within the scope of			Change of raw material
		Initial tests	Surveillance by CI after issue of the certificate[1)]		
			Inspection[2)]	Frequency	
Requirements for the pipe					
Long-term strength	5.2.2	X	X [3)]		X
Appearance	5.2.5	X	X	1x year	X
Material		X	X	1x year	X
Dimensions		X	X	1x year	X
MFR		X	X	1x year	X
Melting temperature adhesive		X			X
Resistance to internal hydraulic pressure		X	X	1x year	X
Thermal stability pipe		X			X
Oxygen permeability		X	X	1x year	X
Longitudinal reversion		X	X	1x year	X
Requirements for the protection pipe					
Material	5.3.1	X	X [3)]		X
Appearance		X	X	1x year	X
Weight per length		X	X	1x year	X
Dimensions		X	X	1x year	X
Resistance to compression		X	X	1x year	X
Resistance to impact		X	X	1x year	X
Resistance to pull force in radial direction (only with duo pipes)		X	X	1x 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 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).

7.2 Evaluation of the quality system

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

8 Requirements imposed on the certification body

8.1 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).

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.

8.2 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.

8.2.1 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 BRLin 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

8.2.2 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.

8.3 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.

8.4 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.

8.5 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 four 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.
If the supplier is the holder of a system (not a manufacturer of a pipe or a fitting), the frequency is set to 1 inspection a year.
If the supplier is a private label owner (identical certificate derived from an (technical approval-with-)product certificate) then the frequency is set at 1 inspection per 2 year.

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.

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

8.6 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.

8.7 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.

8.8 Sanction policy

The sanction policy and the weighing of the non-conformities is available through the service page on the web-site of the certification institute who drafted this guideline.

9 List of mentioned documents

9.1 Norms/ normative documents:

ISO 7-1:1994+C1:2007	Pipe threads where pressure-tight joints are made on the threads – Part 1: Dimensions, tolerances and designation
NEN-EN- ISO 228-1: 2003	Pipe threads where pressure-tight joints are not made on the threads - Part 1: Dimensions, tolerances and designation
NEN-EN-ISO 580: 2005	Plastics piping and ducting systems - Injection-moulded thermoplastics fittings - Methods for visually assessing the effects of heating
NEN-EN-ISO 1133-1: 2011	Plastics - Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics - Part 1: Standard method
NEN-EN-ISO 1167-1:2006	Thermoplastics pipes, fittings and assemblies for the conveyance of fluids - Determination of the resistance to internal pressure
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 en	Copper and copper alloys - Plumbing fittings - Part 6: Fittings with push-fit ends
NEN-EN 1254-8:2012 en	Copper and copper alloys - Plumbing fittings - Part 8: Fittings with press ends for use with plastics and multilayer pipes
BRL 2013:2012+WB:2014	Vulcanized rubber products for hot and cold non-drinking water applications
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 en	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 nl	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)
ISO 4065:1996	Thermoplastic 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 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 10088-1:2014	Stainless steels - Part 1: List of stainless steels

NEN-EN 10283:2010	Corrosion resistant steel castings
NEN-ISO 10508: 2006	Plastics piping systems for hot and cold water installations - Guidance for classification and design
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 11357-3: 2013	Plastics - Differential scanning calorimetry (DSC) - Part 3: Determination of temperature and enthalpy of melting and crystallization
ISO 11922-1: 1997	Thermoplastics pipes for the conveyance of fluids - Dimensions and tolerances - Part 1: Metric series
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-ISO 17455: 2005 / C1:2007	Plastics piping systems - Multilayer pipes - Determination of the oxygen permeability of the barrier pipe
NEN-EN-ISO 22391-2: 2009	Plastics piping systems for hot and cold water installations - Polyethylene of raised temperature resistance (PE-RT) – part 2

I Example IQC-scheme for product manufacturer

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

<u>INTERNAL QUALITY PLAN</u></td><td>Manufacturer / supplier :
Production location address :</td><td>Number of appendices:</td></tr>
<tr><td colspan="3"><u>Field(s) of application</u>

<u>According Evaluation Guideline(s)</u></td></tr>
<tr><td><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><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><u>Inspection and test records</u>
All records shall be maintained for a minimum of years.</td></tr>
<tr><td><u>Specific agreements/comments/explanations</u></td><td colspan="2">Signature of the manufacturer/supplier:

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

[1)] In case the QMS is ISO 9001 certified and covers the scope of the product certificate(s), reference to the applicable procedure(s) on the next pages is sufficient and the tables A till F do in principle not have to be further filled-out except for the frequency of tests/inspections (to be approved by **CI** in tables B, C and D.

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**		

Specific agreements/comments/explanations:

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).

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

II Example IQC-scheme for system holders

SCHEME **INTERNAL QUALITY PLAN**	Producer : Adress : Adress production site :	Page nr. : 1 Number of pages. : Annexes :

Scope(s)

Quality Control Number of employee's in quality department : Number of employee's in dayshift : Number of employee's in nightshift :	Operating instructions and/ or quality manual Operating instructions and procedures are registered as following: .... If no inspections are held during the night then the quality procedure: ..... Is followed
Samplesystem Applied system:	Complaint procedure The complaint procedure is recorded in ....
Storage of the control data All control data is to be kept for a minimum of.....year.	Correcting measures The procedure correcting measures is recorded in ....
Agreements/ clarification	Signature of the producer: Date:

A. Supplied pipes and fittings **Page nr. : 2**

A.1 Delivery

Information when receiving each delivery in respect of date, producer, type and quantity are to be recorded in the following way: .....

A.2 Incoming inspection

What is checked	What aspects are checked	How will the checks be made	With what frequency are the checks performed	Method of registration

Special agreements/ clarification:

B.	**Inspection of the packaging, storage and transportation of the finished product** The guidelines for packing, storage and transport are listed in annex.....			**Page nr. : 3**
What is checked	**What aspects are checked**	**How will the checks be made**	**With what frequency are the checks performed**	**Method of registration**
B.1 Packaging				
B.2 Storage				
B.3 Transport				

C. Supply Installers			Page nr. : 4
What is checked	**What aspects are checked**	**With what frequency are the checks performed**	**Method of registration**

Special agreements/ clarification:

E.	**Complaints procedure** The complaints procedure is detailed in the Qualitymanual procedure ……	**Page nr. : 5**
E.1	**Receiving the complaint**	
E.2	**Research of the cause**	
E.3	**Handeling of the complaint**	

Special agreements/ clarification:

III Corrugated pipes - Compression testing

III.1 Scope

This Annex specifies the test methods for testing the resistance to compression of (flexible) corrugated protection pipes intended as protection pipe sleeves for hot & cold (drinking) water installation pipes.

III.2 Normative references

The following referenced documents are indispensable for the application of this Annex. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.
ISO 3126, *Plastics piping systems — Plastics components — Determination of dimensions*
ISO 9969, *Thermoplastics pipes — Determination of ring stiffness*

III.3 Terms and definitions

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

Compression
the difference between the initial diameter and the diameter of a test piece after compression at a specified load for a given time at a given temperature, the difference being referred to the initial thickness.

Compression set
the difference between the initial diameter and the final diameter of a test piece after compression for a given time at a given temperature and after a given recovery time, the difference being referred to the initial diameter.

III.4 Principle

A test piece is maintained for a specified time at a specified temperature under constant load and the effect on the outer diameter of the test piece is determined after compression and after recovery of this compression load for a specified time.

III.5 Apparatus

Compression testing machine, as specified in ISO 9969, but capable of producing at least the specified diametric deflection of the test piece at the applicable speed.

Dimensional and force measuring devices, conforming to ISO 9969, but capable of measuring diametric deflections up to at least the specified deflection and the corresponding compressive forces.

III.6 Test pieces

Marking and number of test pieces

The pipe of which the resistance to compression is to be determined shall be marked on its outside with a line along one generatrix over its entire length. The marked line shall be exactly on one of the axial weld lines of the pipe sample. Four test pieces, a, b, c and d, respectively, shall be taken from this marked pipe such that the ends of the test pieces are perpendicular to the pipe axis and their lengths conform to 6.2.

Length of test pieces

The length of each test piece shall be (100±1)mm.

III.7 Conditioning

The test pieces shall be conditioned in air at (23±2)°C for at least 24 h prior to testing.

III.8 Procedure

All tests and measurements shall be performed at a temperature of (23±2)°C.
The outside diameters, d_{0a}, d_{0b}, d_{0c} and d_{0d}, of the respective test pieces, a, b, c and d (see 6.1), shall be determined at mid-length cross-section by in accordance with ISO 3126 at the positions respectively 0°, 90°, 180° and 270° in relation to the marking line on the pipe as in clause 6.1. Measurements on the outside diameter shall take into account at least two ribs of the corrugated profile of the pipe.

NOTE By definition: d_{0a} = 0°C, d_{0b} = 90°C, d_{0c} = 180°C and d_{0d} = 270°C.
The parallel plates of the compression testing machine shall be positioned so that contact between the plates is made over the complete area of the plates. This position of the closed plates is set as zero value (y_0=0).

Adjust the position of the parallel plates to be able to place the first test piece in such a way that the marking line is in contact with the upper parallel plate. In the loading device, rotate the three other test pieces, b, c and d, respectively 90°, 180° and 270° in relation to the position of the first test piece (a) when placing them in the loading device. Position the test piece with its longitudinal axis parallel to the plates and with its middle point vertically under the centre-line of the load cell.

NOTE In order to obtain the correct reading from the load cell, it is necessary to position the test piece so the expected resulting force is approximately in line with the axis of the load cell.

Adjust the parallel plates with the sample in-between at a distance from each other equal to the measured outside diameter d_{0a}, d_{0b}, d_{0c} and d_{0d}. Keep the parallel plates at this position for (60±2) s an then adjust the deflection gauge and load cell to zero.

Compress the test piece at a constant speed of (2,0±0,1) mm/min, while continuously recording force and deflection measurements, until reaching a loading force, F, of (200±2) N. This loading force shall be retained at (200±2) N.

At the moment that the full force F is achieved, start the timer (t=0).
Determine the position of the parallel plates from each other (d_{1a}, d_{1b}, d_{1c} and d_{1d}) at (300±2) s after the application of the full load.

Release the loading force (300±2) s after the full force F was achieved to 0 N. After a recovering time of ($60^{+2}/_{-0}$) s for the test piece, determine the positional outer diameters d_{2a}, d_{2b}, d_{2c} and d_{2d} at mid-length cross-section by in accordance with ISO 3126 of the respective test pieces at the same position as in clause 8.1.

III.9 Calculations

Compression after 5 min of loading
Calculate the compression after loading ($C_{200N,5min}$) as the average of the four individual compression measurements as a percentage rounded to three significant figures.

$$C_{\ 200N,5min} = \left\{ 1 - \frac{\left(\frac{d_{1,a}}{d_{0,a}} + \frac{d_{1,b}}{d_{0,b}} + \frac{d_{1,c}}{d_{0,c}} + \frac{d_{1,d}}{d_{0,d}}\right)}{4} \right\} \text{x } 100\%$$

Compression set after 1 min of recovery
Calculate the compression set after recovery (CS_{1min}) as the average of the four measured test pieces as a percentage rounded to three significant figures.

$$CS_{1min} = \left\{ 1 - \frac{\left(\frac{d_{2,a}}{d_{0,a}} + \frac{d_{2,b}}{d_{0,b}} + \frac{d_{2,c}}{d_{0,c}} + \frac{d_{2,d}}{d_{0,d}}\right)}{4} \right\} x\ 100\%$$

III.10 Requirements

$C_{200N,5min}$ ≤ 22,0%
CS_{1min} ≤ 15,0%