Evaluation guideline

for the KiwaQuality certificate for
Plastics piping systems for industrial applications
- multilayer piping systems of PB, PE, PE-RT,
PE-X, PP, ABS, PVC-U, PVC-C and PVDF
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Validation
This evaluation guideline has been validated by the director of Kiwa on July 1, 2011
Preface

This evaluation guideline has been prepared by the Kiwa Board of Experts ‘Plastics piping systems (LKS)’, in which the relevant parties in the field of plastics piping systems for industrial applications are represented. This Board of Experts also guides the performance of certification and updates this evaluation guideline in case necessary. Wherever the term “Board of Experts” is written in this evaluation guideline, the above-mentioned Board of Experts is meant.

Kiwa shall use this evaluation guideline in conjunction with the Kiwa Regulations for Product Certification, in which the formal rules used by Kiwa in the event of certification are laid down.

On the basis of the requirements and test methods of this evaluation guideline, plastics multilayer piping systems are certified for the transport of chemical liquids.

Information from international standards for industrial applications and chemical resistance of plastics have been used for the drafting of this evaluation guideline, as well as reference to international standards has been made where required. At the time of elaboration of this guideline however, no suitable international test method for determination of chemical interactions for certification purposes was available. A unique test method has therefore been developed on the basis of which in principle any chemical liquid in combination with one of the polymers can be tested and certified for defined operational conditions.

A flow schedule, see annex I, figure I.1, is used to classify and standardise the chemical resistance testing procedure to be followed.

Chemical liquid/pipe construction/polymer combinations with a predictable interaction and combinations with interactions regarded as ‘less predictable’ or ‘questionable’ (so-called ‘specialties’) have to be tested with reliable outcome. In order to achieve this, ‘evaluation moments’ are introduced within the test method for the determination of resistance to chemical interactions. These evaluation moments give the guarantee that the right test procedures and test conditions are applied and a maximum of confidence will be obtained. Also additional pre-tests can be used to obtain an indication of the appropriate test conditions. The ‘evaluation moments’ are carried out by qualified person(s) under the responsibility of Kiwa. See the introduction of annex I for more information.

At this moment a conservative testing approach has been chosen in order to assure a maximum of safety and reliability. In this way a sound basis for issuing the KiwaQuality certificates is guaranteed. During the next years the results of testing of new combinations will be used to optimize this guideline.

Already approved polymer/chemical liquid combinations for plastics fitting materials can be found in the ‘List of approved polymers/compounds’. The actualised list is published on the Kiwa website www.1kiwa.com.

For the installation of components conforming to this evaluation guideline, national and/or local requirements and relevant codes of practice shall apply, including safety regulations.
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1 Introduction

1.1 General
This evaluation guideline contains all relevant requirements on the basis of which Kiwa handles an application and maintains a Kiwa Quality (KQ) product certificate for “Plastics piping systems for industrial applications – multilayer piping systems”.

During the performance of the certification work, Kiwa is bound to the requirements as laid down in the chapter “Agreements on the implementation of certification”.

The activities employed by Kiwa on the basis of this evaluation guideline do fulfil the requirements of EN 45011.

Kiwa N.V. accepts no liability for damage or accident claims caused by installed Kiwa certified products.

1.2 Scope
The products are intended to be applied in plastics piping systems for the transport of chemical (hazardous) liquids and gaseous fluids as well as of solid matter in fluids for industrial applications such as:
- chemical plants;
- industrial sewerage engineering;
- power engineering (cooling and general-purpose water supply);
- electroplating and pickling industry;
- the semiconductor industry;
- water treatment.

The plastics piping systems are intended for underground as well as above ground applications. In the case of above ground applications, the piping systems might be directly exposed to sunlight, see par 3.5.4.

Applications in the field of food and feed are not covered by this evaluation guideline.

For applications especially in the field of transport of gaseous and liquid fuels national (legal) requirements, e.g. standards, evaluation guidelines, national certification scheme’s, may be applicable.

This evaluation guideline specifies the characteristics and requirements for the following types of multilayer pipes: P-pipes, M-pipes and F-pipes (see par. 1.7.1 for the definitions), taken into account the following pre-conditions.

For P-pipes the following applies:
- consist of two or more plastics layers;
- consist of at least one stress-designed layer;
- consist of at least one barrier layer;
- other layers with other functions are possible, e.g. for the purpose of identification (layer with a specific colour);
- it is possible that one layer combines more than one of above mentioned functions;
- the type of material of the barrier and chemical protection layer is not specified in this guideline. Chemical resistance requirements apply to the complete pipe, see annex I and permeation requirements can apply only to the barrier layer as well as to the complete pipe, see annex II. No mechanical and physical requirements are imposed on these layers separately, but the complete pipe is tested, see annexes A till L;
- characteristics and requirements for the complete pipe are specified for the materials used for the stress-designed layer(s) as specified in table 1 and the applicable annexes.
For M-pipes the following applies:
- consist of at least one metallic layer;
- consist of at least one metallic stress-designed layer or one plastics stress-designed layer;
- consist of at least one barrier layer;
- consist of at least one chemical protection layer;
- it is possible that one plastics layer combines more than one of above mentioned functions;
- other layers with other functions are possible, e.g. for the purpose of identification (layer with a specific colour);
- the type of material of the chemical protection layer is not specified in this guideline. Chemical resistance requirements apply to the complete pipe, see annex I. No separate permeation tests on the metal barrier layer are required in case this layer is not perforated. And no mechanical and physical requirements are imposed on the chemical protection and barrier layers separately, but the complete pipe is tested, see annexes A till L;
- characteristics and requirements for the complete pipe are specified for the materials used for the stress-designed plastics layer(s) as specified in table 1 and the applicable annexes.

For F-pipes the following applies:
- consist of at least one with fibres\(^1\) reinforced stress-designed plastics layer;
- consist of at least one barrier layer;
- consist of at least one chemical protection layer;
- it is possible that one plastics layer combines more than one of above mentioned functions;
- other layers with other functions are possible, e.g. for the purpose of identification (layer with a specific colour);
- the type of material of the barrier and chemical protection layer is not specified in this guideline. Chemical resistance requirements apply to the complete pipe, see annex I and permeation requirements can apply only to the barrier layer as well as to the complete pipe, see annex II. No mechanical and physical requirements are imposed on these layers separately, but the complete pipe is tested, see annexes A till L;
- characteristics and requirements for the complete pipe are specified for the materials used for the stress-designed plastics layer(s) as specified in table 1 and the applicable annexes.

\(^1\) Wrapped fibre constructions are not covered by this evaluation guideline.

The expected lifetime of the plastics piping system will be stated in the Kiwa Quality certificate.

The requirements embodied in this evaluation guideline are applicable for multilayer piping systems with welded and solvent cemented joints as well as mechanical connections. In case fittings are provided with rubber sealing elements, then these rubber sealing elements have to be certified according BRL KQ-17602.

Remark: especially with regard to installation requirements it is advised to check whether any relevant (safety) regulations in respect of fire behaviour and explosion risk are applicable if applications are envisaged for inflammable media.

Characteristics and requirements which are applicable to the nine materials (PB, PE, PE-RT, PE-X, PP, ABS, PVC-U, PVC-C and PVDF) are covered by the relevant clauses of this evaluation guideline. Those characteristics and requirements which are dependent on the material are for each material of the stress-designed plastics layer given in the relevant annex (see table 1). Hereby the requirements for the weakest stress designed layer (to be calculated) have to be taken into account (the weakest stress designed layer will limit the application).

It is allowed to combine pipes and fittings from different materials in one piping system, e.g. PE-RT pipes with PE fittings.
Table 1 – Stress-designed plastics layer and plastics fittings: material-specific annexes

<table>
<thead>
<tr>
<th>Material</th>
<th>Annex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polybutene (PB)</td>
<td>A</td>
</tr>
<tr>
<td>Polyethylene (PE)</td>
<td>B</td>
</tr>
<tr>
<td>Polyethylene of raised temperature resistance (PE-RT)</td>
<td>C</td>
</tr>
<tr>
<td>Crosslinked polyethylene (PE-X)</td>
<td>D</td>
</tr>
<tr>
<td>Polypropylene (PP)</td>
<td>E</td>
</tr>
<tr>
<td>Acrylonitrile-butadiene-styrene (ABS)</td>
<td>F</td>
</tr>
<tr>
<td>Unplasticized polyvinyl chloride (PVC-U)</td>
<td>G</td>
</tr>
<tr>
<td>Chlorinated polyvinyl chloride (PVC-C)</td>
<td>H</td>
</tr>
<tr>
<td>Polyvinylidene fluoride (PVDF)</td>
<td>J</td>
</tr>
<tr>
<td>PolyPhenylSulfone (PPSU)</td>
<td>K</td>
</tr>
</tbody>
</table>

1) Requirements are only applicable for fittings of PPSU

1.3 Certification scheme in relation to chemical resistance testing

Within the framework of certification of a piping system, the by the applicant proposed PAR (see definitions), have to be confirmed by the certification body via the proposed tests and requirements of this evaluation guideline.

An important point of departure hereby is that the chemical resistance testing and approval takes place:
- on the level of raw materials/compounds for plastics monolayer fittings (so-called ‘material tests’);
- on the level of complete pipe construction for multilayer pipes (end product, so-called ‘product tests’);
- The chemical resistance tests of the joints are carried out for each piping system to be certified (are ‘product tests’).
Figure 1: Flow chart of chemical resistance testing as part of certification process

Pipe and/or fitting manufacturer and/or system holder applies for KQ certification

> Information from applicant about characteristics of the piping system and application conditions:
> - construction details (build up) of pipes;
> - type of plastics and metal material fittings and pipe layers;
> - geometrical characteristics of pipes and fittings;
> - applicable operating, maximum and malfunctioning temperature(s);
> - applicable operating and maximum pressure(s);
> - chemical liquids to be transported, including concentrations;
> - intended lifetime (years).

Chemical resistance testing pipe

Chemical resistance testing of multilayer pipe according annex I

Continuation of KQ certification and testing, including chemical resistance test of the joints

Piping system approved?

Yes

Issue of KQ pipe certificate per production location; Issue of KQ fitting certificate per production location and issue of KQ certificate for the system

No

Re-tests

Is/are raw fitting material(s) approved for the intended chemical liquids and application conditions?

Chemical resistance testing on fitting material according annex I of BRL KQ-17601

1:
- According to list of approved polymers/compounds. This list will be publicly kept available by Kiwa on Kiwa website

2:
- During evaluation moment I, see par. I.3.2, it is assessed whether chemical resistance tests are required
1.4 Terms
In this evaluation guideline is meant by:

- Evaluation Guideline: the agreements made within the Board of Experts with regard to the subjects of certification;
- Board of Experts: the Board of Experts “Plastics piping systems”;
- Supplier: the party responsible for ensuring that the products continuously fulfil the requirements on which the certification is based; *Note: the ‘Supplier’ may also be the manufacturer of the certified product(s).*
- IQC-scheme: a description of the quality controls carried out by the supplier as part of his quality system.

1.5 Acceptance of test reports provided by the supplier
The rules for acceptance of test reports provided by the supplier are laid down in the Kiwa Regulations for Product Certification.

1.6 Quality declaration (certificate)
The quality declarations to be issued by Kiwa are described as KiwaQuality® (KQ) product certificates.
The general models of the KQ certificates which will be issued on the basis of this evaluation guideline has been appended as annexes to this guideline (see appendix III, IV and V).

Only a complete piping system consisting of pipes and fittings will be certified and therefore a minimum of three certificates will be issued in the event of certification: a certificate for the pipes, a certificate for the fittings and one certificate for the system. The existence of a certificate only for pipe or fitting, without a certificate for the system is not possible. The three mentioned certificates do not have to belong to the same applicant.

Only the front page of the certificate will be publicly available via the Kiwa website. The complete certificate, including information about the chemical liquids to be transported including their product approval ranges, have to be obtained via the certificate holder(s) or can be issued by Kiwa only after approval of the certificate holder(s).

See appendix VII for detailed explanation concerning the identification of the products in relation to the issue of the certificates and marking of the products.

1.7 Procedure for granting the quality declaration

1.7.1 Precertification tests
The precertification-tests to be performed are based on the (product) requirements as included in this evaluation guideline including the test methods and contain, depending on the nature of the product to be certified:

- type testing to determine whether the products comply with the product and/or functional requirements;
- Production Process Assessment;
- Assessment of the quality system and the IQC-scheme;
- Assessment on the presence and functioning of the remaining procedure.

1.7.2 Granting the quality declaration
After finishing the precertification tests the results are presented to the person deciding on granting of certificate. This person evaluates the results and decides whether the certificate can be granted or additional data and/or tests are necessary.

1.8 Terms and definitions
For the purposes of this evaluation guideline, the terms and definitions given in ISO 3, ISO 472 and ISO 1043-1 and the following apply.
1.8.1 Definitions related to construction

- **multilayer pipe**
  pipe comprised of different layers.

- **multilayer P-pipe**
  pipe comprised of one or more polymeric stress-designed layer(s), one or more polymeric barrier layer(s) and possibly one or more inside chemical protection layer(s) (e.g. PA/PE-HD or PE-Xb/PA/PE-HD).

- **multilayer M-pipe**
  pipe comprised of one or more polymeric layer(s) and/or one or more metallic layer(s) (e.g. PE-Xb/Al/PE-Xb or PE-RT/Al/PE-Xb). At least one layer functions as a stress-designed layer. The inside polymeric layer functions as a chemical resistance protection layer.

  NOTE The wall thickness of the pipe consists of at least 60% of polymeric material.

- **multilayer F-pipe**
  pipe comprised of one or more with fibres reinforced polymeric stress-designed layer(s) (e.g. PP-R/Glass_PP-R/PP-R or PE-RT_Glass/PE-Xb). The inside polymeric layer functions as a chemical resistance protection layer.

  NOTE The wall thickness of the pipe consists of at least 60% of polymeric material.

- **inner layer / chemical protection layer**
  the layer in contact with the chemical liquid which is conveyed, which functions as the chemical protection layer.

- **similar construction type**
  definitions according ISO 17645, par. 3.4 and 3.5 are applicable, whereby the requirement for SDR variation of 10% is applicable for each stress designed layer.

- **outer layer**
  the layer exposed to the outer environment.

- **barrier layer**
  can be plastics inner layer or plastics or metal layer between the outer and inner layers, which functions as a barrier for the permeation of chemical liquids through the pipe wall.

- **stress-designed plastics layer**
  plastics layer which is designed to be stress-bearing.

  NOTE The material used in such layers is restricted to those mentioned in table 1.

- **fitting**
  piping system component which connects two or more pipes and/or fittings together without any further function.

  NOTE 1 Examples of mechanical fittings are compression fittings, crimped fittings, flanged fittings, flat seat union fittings and push fittings.

  NOTE 2 Examples of fusion fittings are socket fusion fittings, electrofusion fittings, fittings with incorporated inserts and solvent-cemented fittings.
• fibre
  A thread or bundle of filaments from any material intended to be a part of the stress
designed layer.

1.8.2 Definitions related to geometry
• group of dimensions
  Dimension group 1: all diameters equal or below 63 mm
  Dimension group 2: all diameters above 63 mm and equal or below 320 mm
  Dimension group 2: all diameters above 320 mm and equal or below 630 mm
  Dimension group 4: all diameters above 630 mm

• nominal outside diameter
  \( d_n \)
  specified outside diameter, in millimetres, assigned to a nominal size (DN/OD or
  DN/ID).

• outside diameter
  \( d_e \)
  outside diameter measured through the pipe cross-section at any point on the pipe, or
  the spigot end of a fitting, rounded up to the nearest 0,1 mm.

• inside diameter
  \( d_i \)
  inside diameter measured through the pipe cross-section at any point on the pipe, or
  the spigot end of a fitting, rounded up to the nearest 0,1 mm.

• wall thickness
  \( e \)
  measured wall thickness at any point around the circumference of a component,
  rounded up to the nearest 0,1 mm.

• minimum wall thickness
  \( e_{\text{min}} \)
  minimum value of the measured wall thickness at any point around the circumference
  of a component, rounded up to the nearest 0,1 mm.

• metal layer standard dimension ratio
  \( SDR_m \)
  outside diameter of the metal layer of a pipe divided by the wall thickness of the
  metal layer.

• polymeric layer standard dimension ratio
  \( SDR_p \)
  outside diameter of the polymeric layer of a pipe divided by the wall thickness of the
  polymeric layer.

1.8.3 Definitions related to materials
• virgin material
  material in a form such as granules or powder that has not been subjected to use or
  processing other than that required for its manufacture and to which no reprocessable
  or recyclable material has been added.

• own reprocessable material
  material prepared from clean unused rejected pipes or fittings, that will be
  reprocessed in a manufacturer’s plant after having been previously processed by the
  same manufacturer by a process such as moulding or extrusion and for which the
complete formulation is known.

NOTE 1 Such material may include trimmings from the production of such pipes and fittings.

1.8.4 Definitions related to material characteristics

- **long-term pressure strength**
  
  lower confidence limit of the predicted hydrostatic pressure $P_{LPL}$

  quantity, with the dimensions of pressure, which represents the 97.5% (one-sided) lower confidence limit of the predicted hydrostatic pressure at a temperature $T$ and time $t$.

- **design pressure**
  
  $P_D$

  highest pressure related to the circumstances for which the system has been designed and is intended to be used.

- **melt mass-flow rate**
  
  MFR

  value relating to the viscosity of a molten material at a specified temperature and rate of shear, expressed in grams per ten minutes (g/10 min).

1.8.5 Definitions related to service conditions

- **overall service (design) coefficient**
  
  $C$

  overall coefficient, with a value greater than one, which takes into consideration service conditions as well as the properties of the components of a piping system other than those represented in the lower confidence limit, $P_{LPL}$.

- **nominal pressure**
  
  $P_N$

  numerical designation used for reference purposes and related to the mechanical characteristics of the components of a piping system.

- **product approval range (PAR)**
  
  definition of the applicable and approved operational and maximum temperatures, pressures, the maximum concentration of the chemical liquid and lifetime of the piping system for a certain chemical liquid to be transported. For each chemical liquid to be transported by a specified piping system, the accompanying PAR has to be defined and will be included in the KQ-certificate.

- **operating temperature**
  
  $T_{oper}$

  temperature of the conveyed chemical liquid related to the circumstances for which the system has been designed; to be declared by the applicant for a chemical liquid to be transported (part of the PAR)

- **maximum (operating) temperature**
  
  $T_{max}$

  highest operational temperature, $T_{oper}$, occurring for short periods only; to be declared by the applicant for a chemical liquid to be transported (part of the PAR)

- **malfunction temperature**
  
  $T_{mal}$

  highest temperature that can be reached when the control limits are exceeded, to be
declared by the applicant for a chemical liquid to be transported (part of the PAR).

- **operating pressure**
  \[ P_{oper} \]
  is equal to the nominal pressure and related to the circumstances for which the system has been designed; to be declared by the applicant for a chemical liquid to be transported (part of the PAR).

- **maximum pressure**
  \[ P_{max} \]
  maximum pressure related to the circumstances for which the system has been designed; to be declared by the applicant for a chemical liquid to be transported (part of the PAR).

### 1.9 Symbols and abbreviated terms

#### 1.9.1 Symbols

- \( C \) overall service (design) coefficient (design factor)
- \( d_i \) inside diameter
- \( d_e \) outside diameter
- \( d_n \) nominal diameter
- \( e_n \) nominal wall thickness
- \( e_{min} \) minimum wall thickness
- \( F_{pull} \) adhesive strength
- \( pF \) hydrostatic test pressure (in bars) to be applied to the assembly during the test period
- \( pD \) design pressure (in bars)
- \( pLPL \) long-term pressure strength (lower confidence limit of the predicted hydrostatic pressure)
- \( T \) temperature
- \( TD \) design temperature
- \( T_{mal} \) malfunction temperature
- \( T_{max} \) maximum design temperature
- \( t \) time
- \( \sigma \) hydrostatic stress

#### 1.9.2 Abbreviations

- ABS acrylonitrile-butadiene-styrene
- MFR melt mass-flow rate
1.10 **Classification conditions**

The following classification conditions apply:

- Operating temperature(s): to be stated by the manufacturer;
- Concentrations of the chemical liquids: to be stated by the manufacturer;
- Intended lifetime of the piping system: to be stated by the manufacturer;
- Nominal (working) pressure of the piping system: to be stated by the manufacturer;
- Exposure to weathering: directly and not-directly exposed to sunlight, to be stated by the manufacturer.

1.11 **Legal requirements**

This evaluation guideline does not take into account any legal or other relevant requirements with regard to installation, safety, environmental aspects etc of the piping systems to be installed.
2 Material requirements

2.1 General
The pipe manufacturer shall declare the materials used for each layer of the multilayer pipe and the function of each layer.
The fitting manufacturer shall declare the materials used for (the different parts of) the fitting.

The material of the stress-designed polymeric layers of the pipes as well as the plastics fittings material, shall be PB, PE, PE-RT, PE-X, PP, ABS, PVC-U, PVC-C, PVDF or PA as applicable, to which are added those additives that are needed to facilitate the manufacture of pipes and fittings conforming to this evaluation guideline.

2.2 Recording of applied raw materials and additives
Types of raw materials and additives used for the manufacturing of the pipes and fittings shall be laid down in writing between the manufacturer of the pipes and fittings and Kiwa Nederland B.V.

2.3 Evaluation of $s_{LPL}$-values
In the absence of established $s_{LPL}$-values, the polymeric material of the stress-designed layers of the pipes as well as the polymeric plastics material of the fittings shall be evaluated in accordance with EN ISO 9080 or equivalent where internal pressure tests are made with water in accordance with EN-ISO 1167 to find the $s_{LPL}$-values. The $s_{LPL}$-values thus determined shall at least be as high as the corresponding values of the reference curves as referred to for each material in the applicable annex to this evaluation guideline (see the paragraph ‘Hydrostatic strength properties in each applicable annex’).

For other plastics fitting materials not specified above, the following applies.
The fitting material in the form of injection-moulded tubular test pieces or extruded pipe shall be evaluated by the method given in ISO 9080, or equivalent, by internal pressure testing carried out in accordance with the relevant parts of ISO 1167.

For the classification of a material intended only for the manufacture of fittings, an injection-moulded or extruded test piece in the form of a pipe shall be used (see Figure 1 of ISO 15493) and the test pressure applied in accordance with ISO 1167. The free length $l_0$ shall be $3d_n$, as defined in ISO 15853.

2.4 Metallic fitting material
The metal fitting material from which the fitting body is made of shall comply with internationally accepted standards (like e.g. NEN-EN 1254 series for fittings made of copper and copper alloys or EN 10088 series for fittings of stainless steel).
For chemical resistance in specific applications, respective internationally accepted chemical resistance tables are to be consulted, see annex I.

2.5 Other characteristics of the material
Details of requirements on other characteristics of the materials concerned are given in the applicable annexes to this evaluation guideline.

2.6 Reprocessable and recyclable material
The use of reprocessable material obtained during the production and testing of pipes and fittings in accordance with this evaluation guideline is permitted in addition to virgin material, provided that the requirements of this evaluation guideline are fulfilled.

Reprocessable material obtained from external sources and recyclable material shall not be used.
3 Product requirements

3.1 General characteristics

3.1.1 Appearance
When viewed without magnification, the internal and external surfaces of the components shall be smooth, clean and free from any scoring, cavities and other surface defects that would prevent conformity to this evaluation guideline. The components shall not contain visible impurities.

Each end of a component shall be square to its axis and shall be deburred.

3.1.2 Colour
The colour of the pipes and fittings is not prescribed, but will be laid down in the KQ-certificate to be issued.

NOTE Attention is drawn to the need to take account of any relevant legislation relating to the colour coding of piping in respect of its purpose or contents for the location in which the components are intended to be used.

3.1.3 Opacity
Multilayer pipes that are declared to be opaque shall not transmit more than 0,2 % of visible light, when tested in accordance with ISO 7686. This requirement is not relevant to M-pipes.

Fittings that are declared to be opaque shall not transmit more than 0,2 % of visible light, when tested in accordance with ISO 7686. The test shall be carried out on the fitting with the smallest wall thickness in the manufacturer’s range.

3.2 Construction of pipes
Multilayer pipes can include layers made of polymer, layers made of metal or polymeric layers reinforced with fibres (e.g. glass fibres).

For example, layers may have the following purposes:
• the ability to withstand pressure;
• the ability to block or greatly reduce the permeation of oxygen or other (chemical) substances through the pipe wall;
• the ability to create interlayer adhesion;
• the ability to block or greatly diminish the effect of UV and/or sunlight;
• the ability to mechanically protect all other layers (inside layer or outside layer);
• the ability to control the longitudinal expansion;
• the ability to give the multilayer pipe a colour (inside layer or outside layer).

Some characteristics can be combined in the same layer.

3.3 Geometrical characteristics

3.3.1 General
Dimensions shall be measured in accordance with ISO 3126 at (23 ± 2) °C after the component has been conditioned for at least 4 h. The measurements shall not be made less than 24 h after manufacture.

3.3.2 Diameters, wall thicknesses and associated tolerances
The nominal outside diameter should preferably be in accordance with ISO 161-1.

The diameters, wall thicknesses and associated tolerances of the pipes and fittings shall conform to the specifications of the manufacturer. These specifications are laid down between
the manufacturer and Kiwa (e.g. in technical drawings or file), in an annex to the IQC-schedule (see annex VI).

3.3.3 **Angles**

The permitted deviation from the nominal or declared angle of a non-linear fitting (i.e. the change in direction of the axis of the flow through the fitting) is $\pm 2^\circ$.

**NOTE** The preferred nominal angles for elbows are 45° and 90°.

3.3.4 **Threads**

Threads used for joining shall conform to ISO 7-1. Where a thread is used as a fastening thread for joining (e.g. union nuts), it shall conform to ISO 228-1.

3.4 **Mechanical characteristics**

3.4.1 **General**

The mechanical characteristics of pipes and fittings (including sealing elements) shall conform to the requirements as mentioned in the following paragraphs. Depending on the plastics material, additional requirements for fittings might be applicable which are included in the corresponding annexes to this evaluation guideline.

3.4.2 **Pressure strength pipes**

**Long-term pressure strength ($p_{LPL}$)**

For P-pipes, M-pipes as well as F-pipes the hydraulic pressure strength shall be determined in accordance with clause 9.1 of ISO 21003-2.

1) In case of P-pipes and M-pipes, whereby only one plastics layer is the stress-designed layer, a 4.000h/Tmax confirmation test according ISO 17456, par. 6.2.4 has to be carried out on the weakest dimension.

**Design pressure strength ($p_D$)**

The design pressure strength is derived from the long-term pressure strength, taking into account the by the applicant specified application conditions and the overall design coefficients as referenced to in clause 9.2 of ISO 21003-2.

1) Remark: a so-called full ISO 9080 long term hydrostatic strength (LTHS) test is not required in case the lifetime of the piping system with the particular chemical liquid to be transported is short. Determination of the required data from the LTHS-test requires a separate evaluation moment.

3.4.3 **Pressure strength fittings**

See the relevant paragraphs of the applicable annexes A till L to this evaluation guideline.

3.4.4 **Sealing elements**

The sealing elements shall have no detrimental effect on the properties of the pipe or fitting and shall not cause the test assembly to fail. The material of elastomeric sealing elements used in joint assemblies shall conform to BRL KQ-17602.

3.4.5 **Strength of the weld line of M-pipes**

The strength of the weld line is covered by the control points for the resistance to inner water pressure test in accordance with ISO 17456.

3.5 **Physical characteristics**

3.5.1 **General**

The physical characteristics of pipes and fittings shall conform to the requirements as mentioned in the following paragraphs. Depending on the plastics material, additional
requirements for pipes and fittings might be applicable which are included in the corresponding annexes to this evaluation guideline.

3.5.2 Resistance to wear and abrasion

The influence of wear and abrasion by any solid matter in the fluid on the lifetime of the piping system shall be estimated and taken into account at the design of the piping system, see par. 4.5. Relevant documentation shall be provided by the applicant to the certification body as proof that the influence of wear and abrasion has been sufficiently dealt with.

3.5.3 Resistance to impact

3.5.3.1 General

In case of low temperature applications, an impact test is required in case:
- the operational temperature of the conveyed chemical liquid is \(< 10 \, ^\circ C\);
- the specified environmental / outside temperature is \(< 10 \, ^\circ C\).

The lowest specified temperature is \(T_{test}\) (see par. 3.5.3.2) and is part of the assessment during evaluation moment I, see par. I. 3.2.

3.5.3.2 Impact test

This requirement applies to assembled pipes and fittings.

Three samples shall be used for each test. Unless otherwise specified the samples shall be assemblies consisting of lengths of pipe, one of which shall have a minimum free length of 375 mm or three times the external diameter, whichever is the greater, together with examples of the connectors as appropriate. The fittings are assembled in accordance with the manufacturer’s instructions.

Condition the samples for a minimum period of 1 h in air at \((T_{test} \pm 2) \, ^\circ C\).

Remove the samples from this environment and test them within 5 min. Place the samples on a flat surface or in a ‘V’ block directly supporting the pipe or connector below the point of impact and at the same temperature. Impact each pipe at its centre point, and each connector, with a \((50 \pm 1) \, mm\) diameter hemispherical striker weighing \((0,5 \pm 0,03) \, kg\), dropped from a height of \((1,8 \pm 0,05) \, m\).

Inspect the samples for signs of cracking. No signs of leakage or cracking shall be visible.

3.5.4 Resistance to weathering

In case the piping systems are intended to be exposed directly to weathering and sunlight (U.V.), the applicant for certification has to provide relevant information (e.g. test reports, experimental data) which gives proof that the pipes and fittings have sufficient resistance to weathering and U.V. for the intended lifetime and intended location(s) of installation of the piping systems.

Hereby it is important that the types of raw materials and additives (if applicable) applied are laid down between the manufacturer(s) of the pipes and fittings and Kiwa Nederland B.V., see par. 2.2 in order to guarantee by inspections (see chapter 6) that only the approved raw materials and additives are applied.

3.5.5 Thermal durability of P-pipes

For P-pipes, the stress-designed layers shall be tested for thermal stability as described in the relevant annexes to this evaluation guideline (in case applicable, see the relevant annex(es)). The wall thickness of the test pieces shall be equal to the smallest wall thickness in the diameter range.

3.5.6 Thermal durability of M-pipes and F-pipes

Inner layer

For M-pipes and F-pipes, the material of the inner layer shall be tested for thermal stability as described in the relevant annexes to this evaluation guideline (in case applicable, see the
relevant annex(es)). The test pieces shall have a maximum wall thickness of \(2 \times\) the thinnest wall thickness allowed for the inner layer.

**Outer layer**

The thermal durability of the outer layer shall be determined either on the pipe with the thinnest outer layer for each dimension group in accordance with Annex C of ISO 21003-2 or, provided the outer layer is a polyolefin, in accordance with Annex C or Annex D of ISO 21003-2 irrespective of the thickness of the outer layer.

3.5.7 **Metal layer**

In case the metal layer functions as a stress-designed layer, the manufacturer shall specify the tensile strength, the elongation at break and the wall thickness including tolerances.

3.5.8 **Fibres reinforced polymeric layer**

The manufacturer shall specify all relevant characteristics of the fibres used in the fibres reinforced polymeric layer as well as the characteristics of the layer itself.

3.6 **Chemical characteristics**

3.6.1 **Resistance to chemicals**

By means of testing in accordance with annex I, it has to be confirmed that the materials of pipes and fittings coming directly into contact with the chemical liquid(s) to be transported, as well as the joint assemblies of the piping system, are suitable to be applied for the intended lifetime and application conditions (operating temperatures and nominal pressures).

3.6.2 **Resistance to permeation**

By means of testing in accordance with annex II, the permeation rate(s) through the pipe and fitting wall are measured and the total of these rates will be mentioned in the KQ certificate for the system (technical approval-with-product certificate, see annex III).

Permeation requirements are applicable for P-pipes, F-pipes and M-pipes with perforated metal layer as well as plastics fittings.

1) In the case of high permeation rates it is recommended to check whether (inter)national environmental regulations with regard to dangerous substances have to be taken into account.

3.7 **Adhesives**

The type(s) of adhesive(s) tested form(s) part of the piping system to be certified.
4 System requirements

4.1 Strength of the joints

4.1.1 General
When pipes and fittings are jointed together, all pipes and fittings, as well as the joints between them, shall conform to the requirements for ‘hydrostatic strength’ according 4.1.1.1.

4.1.1.1 Internal pressure test
When tested in accordance with ISO 1167 using the test parameters according table 2 and as explained below, the joint assemblies shall not leak.

The test pressure, $P_F$, for a given time to failure and test temperature shall be determined by the following equation:

$$P_F = P_D \times 1.5$$

Where:
$P_F$ is the hydrostatic test pressure, in bars, to be applied to the assembly during the test period;
$P_D$ is the design pressure in bar, as applicable (2 bar, 4 bar, 6 bar, 8 bar, 10 bar etc).

<table>
<thead>
<tr>
<th>Table 2 – Test parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test temperature, in °C</strong></td>
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<tr>
<td></td>
</tr>
<tr>
<td><strong>Test duration, in h</strong></td>
</tr>
<tr>
<td><strong>Number of test pieces</strong></td>
</tr>
<tr>
<td><strong>Test pressure, $P_F$, in bars</strong></td>
</tr>
</tbody>
</table>

4.1.2 Preparation of test assemblies

4.1.2.1 General
The joints shall be tested using pipes and fittings conforming to this evaluation guideline.

The preparation of test assemblies shall take into account tolerances related to component manufacture, field assembly and the equipment used, ambient-temperature variations during installation and, where appropriate, sealing material and associated tolerances.

Test assemblies for pressure tests shall be closed with pressuretight end-load-bearing end caps, plugs or flanges which shall be provided with connections for the entry of water and release of air.

4.1.2.2 Heated tool joining
Butt fusion and infrared fusion joining
Pipes and spigot-ended fittings designed for joining by butt fusion and infrared fusion (PVDF) shall be prepared and assembled in accordance with the manufacturer’s instructions.

Socket fusion joining
Pipes and fittings designed for joining by socket fusion shall be prepared and assembled in accordance with the manufacturer’s instructions.

Saddle fusion joining
Pipes and fittings designed for joining by saddle fusion shall be prepared and assembled in accordance with the manufacturer’s instructions.

4.1.2.3 **Electrofusion joining**

Pipes and fittings such as couplers or saddles designed for joining by electrofusion shall be prepared and assembled in accordance with the manufacturer’s instructions.

In addition, socket fusion fittings shall be assembled at the maximum radial clearance identified for testing purposes. For couplings of nominal outside diameter $d_n \geq 225$ mm, the adjoining pipes shall be arranged to provide an angular deflection of 1,5°.

4.1.2.4 **Saddle fittings**

Saddle fittings (for electrofusion and heated-tool fusion) which are designed for joining to a pressurized pipe shall be fusion-jointed to a test pipe while the pipe is pneumatically or hydraulically pressurized to the maximum permitted operating pressure specified in the manufacturer’s instructions.

**WARNING —** Precautions to minimize the risk of injury should be taken, particularly when the test piece is pressurized pneumatically. In addition, relevant safety regulations should be taken into account.

Threaded caps on saddle fittings shall be assembled for testing without any mechanical support.

4.1.2.5 **Solvent cement joining**

Pipes and fittings designed for solvent cement joining shall be prepared and assembled in accordance with the manufacturer’s instructions.

4.1.2.6 **Mechanical joining**

Pipes and fittings designed for mechanical joining shall be prepared and assembled in accordance with the manufacturer’s instructions.

4.1.3 **Fusion-joining compatibility of components and materials**

The component manufacturer shall declare which components and materials conforming to this evaluation guideline may be fusion-jointed using the same instruction(s) (e.g. fusion-joining times, temperatures and pressures) to give a joint which conforms to the requirements of this evaluation guideline. If there is a need for deviations from the fusion-joining procedure, the manufacturer shall state this.
4.2 Marking of the pipes and fittings

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

Pipes:
- KQ Industry (or KiwaQuality®Industry) word mark;
- Manufacturer’s name and/or trade name and/or system name and/or logo;
- Certificate number of the accompanying technical approval-with-product certificate;
- BRL-K17603;
- Material identification, e.g. PA/PE-RT or PE-X/Al/PE- X\textsuperscript{1)} etc.;
- Nominal outside diameter and nominal wall thickness of the pipe in mm;
- Date of production (may be provided in code).

These marks shall be provided on the pipes at intervals of not more than 2 m.

Fittings:
- KQ Industry (or KiwaQuality®Industry) word mark, if not possible, then only on the smallest packaging unit;
- Manufacturer’s name and/or trade name and/or system name and/or logo;
- Nominal outside diameter of the corresponding pipe in mm;
- Production code (e.g. clock with indication of year and month).

The smallest packaging unit of the fittings shall be provided with at least the following information:
- KQ Industry (or KiwaQuality®Industry) word mark;
- Manufacturer’s name and/or trade name and/or system name and/or logo;
- Certificate number of the accompanying technical approval-with-product certificate;
- BRL-K17603;
- Material identification, e.g. PA/PE-RT or PE-X/Al/PE- X\textsuperscript{1)} etc.;
- Nominal outside diameter of the corresponding pipe in mm;
- Date of production (may be provided in code).

\textsuperscript{1)} In case two different types of the same polymer (PB, PVC, etc) are used, material identification shall be e.g. ‘PB1’, ‘PB2’ etc. This will be mentioned in the certificate(s) as well.

Remark:
See also appendix VII for an explanation concerning identification of the products in relation to the marking and the PAR of the products.

4.3 Classification of pipes, fittings and system

The following classification conditions apply:
- Operating temperature(s): to be stated by the manufacturer;
- Concentrations of the chemical liquids: to be stated by the manufacturer;
- Intended lifetime of the piping system: to be stated by the manufacturer;
- Nominal (working) pressure of the piping system: to be stated by the manufacturer;
- Environmental / outside temperature: to be stated by the manufacturer;
- Exposure to weathering: directly and not-directly exposed to sunlight, to be stated by the manufacturer.

4.4 Change in design, in material and/or in the production method

Any changes in design, in material and/or in the production method - other than routine in-process adjustments, and/or extensions of the product range - having impact on the quality of the product(s), can lead to retesting, see par. 4.1. It is the responsibility of the certificate holder to inform Kiwa about relevant changes. Any retesting shall be agreed upon between the manufacturer and Kiwa.
4.5 Design of a multilayer piping system for industrial applications

NOTE Due to the fact that there are several calculation methods available for the design of thermoplastics piping systems for industrial applications, only general guidance can be given.

For the design of a piping system (e.g. determination of the maximum allowable pressure and lifetime), the following parameters should be taken into account:
- the temperature, T, regarded to be constant;
- the pressure, p, regarded to be constant;
- the intended lifetime, t;
- the design pressure, $p_D$, as applicable;
- the chemical resistance of the material to the fluid;
- the influence of wear and abrasion by any solid matter in the fluid;
- the influence of changes in length (caused by temperature, swelling, internal pressure);
- the kind of installation (fixed, floating, etc.);
- the distances between supports in the installed piping system.

With these parameters, together with the minimum required hydrostatic strength curves, a piping system can be designed taking into account any national and/or local requirements and, where appropriate, backed up by experimental design methods.

See also figure 1 for the flow chart of the certification and chemical resistance testing of industrial piping systems on the basis of this evaluation guideline, in which the design of the piping system plays an important role.

4.6 Installation and user instructions

For the installation of components conforming to this evaluation guideline, national and/or local requirements and relevant codes of practice shall apply, including safety regulations.

The manufacturer shall further provide proper written installation and users’ instructions in the language of the country where the piping systems are to be installed and used, covering transport, storage and handling of the components, as well as their installation in accordance with applicable national and/or local requirements. These instructions shall reference compliance with these national environmental regulations pertaining to the storage and transport of chemicals. National regulations can stipulate requirements for e.g. preventing accidental impact to the piping system and leak detection. National regulations may e.g. stipulate also that the installation is to be carried out by installers certified in accordance with national legislation and requirements. The instructions shall include the precautions to be taken and the testing requirements when testing the piping system on site.
# 5 Quality system requirements

## 5.1 General
This chapter contains the requirements that have to be fulfilled by the manufacturer’s quality system.

## 5.2 Manager of the quality system
Within the manufacturer’s organisational structure an employee shall be appointed who is in charge of managing the quality system.

## 5.3 Internal quality control/quality plan
As part of the quality system the manufacturer shall implement an internal quality control schedule (IQC-scheme).

In this IQC-scheme the following shall be demonstrably recorded:
- which aspects are inspected 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-schedule shall be in the format as shown in the annex. The schedule shall be detailed in such a way that it provides Kiwa sufficient confidence that requirements will be continuously fulfilled.

## 5.4 Procedures and work instructions
The manufacturer shall 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.
- the work instructions and inspection sheets in use.
- instructions for packaging and closing off of products during storage and transport.

## 5.5 External inspection
The supplier’s quality system shall be assessed by Kiwa with regard to at least the aspects mentioned in the Kiwa-Regulations for Product Certification.

The Central Board of Experts will determine the inspection frequency. At the time of validation of this evaluation guideline the inspection frequency has been set at 4 inspection visits per year. In case the manufacturer is ISO 9001 certified\(^1\) for the scope and production location concerned, the frequency has been set at 2 inspection visits per year.

\(^1\) The certification institute performing the ISO 9001 certification shall be accredited by an accreditation body which is a member of EA (European co-operation for accreditation) or other by EA recognised regional accreditation body.
6 Summary of tests and inspections

This chapter contains a summary of tests and inspections to be carried out during:

**Pre-certification tests**: the investigation necessary in order to determine whether all requirements of the evaluation guideline are fulfilled (e.g. initial type tests).

**Inspection visit**: the surveillance inspections carried out after issue of the certificate in order to determine whether the certified products continuously fulfill the requirements of this evaluation guideline. The inspections are carried out according to the frequency indicated.

**Inspection of the quality system**: inspection with regard to the correct implementation of the IQC-scheme and procedures.

### 6.1 Matrix for initial type tests and inspection tests

The table below contains a summary of the investigations and tests to be carried out in the event of certification.

<table>
<thead>
<tr>
<th>Description of requirement</th>
<th>Article BRL</th>
<th>Tests within the scope of</th>
<th>Inspection by Kiwa after issue of the certificate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Initial evaluation</td>
<td></td>
</tr>
<tr>
<td>Evaluation of $\sigma_{1%}$-values</td>
<td>2.3</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Metallic fitting material</td>
<td>2.4</td>
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<td>X</td>
</tr>
<tr>
<td>Other characteristics of the material</td>
<td>2.5</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Reprocessable and recyclable materials</td>
<td>2.6</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>General characteristics</td>
<td>3.1</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Geometrical characteristics</td>
<td>3.3</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mechanical characteristics</td>
<td>3.4</td>
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<td>X</td>
</tr>
<tr>
<td>Physical characteristics</td>
<td>3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical characteristics</td>
<td>3.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adhesives</td>
<td>3.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance requirements</td>
<td>4.1</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Certification mark</td>
<td>4.2</td>
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<td>X</td>
</tr>
<tr>
<td>Classification of components</td>
<td>4.3</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Installation and user instructions</td>
<td>4.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material annex A</td>
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<td>X</td>
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<tr>
<td>Material annex B</td>
<td>B</td>
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<td>X</td>
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<tr>
<td>Material annex C</td>
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<td>Material annex D</td>
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<td>Material annex E</td>
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<td>Material annex F</td>
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<tr>
<td>Material annex G</td>
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<tr>
<td>Material annex H</td>
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<tr>
<td>Material annex J</td>
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<tr>
<td>Material annex K</td>
<td>K</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

1) When significant changes of the product or production process occur, the initial evaluation has to be carried out again, see also par. 2.16.

2) All product properties which can be determined within the inspection time (maximum 1 day) are determined by the inspector or by the certificate holder in presence of an inspector. When this is not possible arrangements, how inspection will take place, will be made for this aspect between the CB and the certificate holder.

3) Tests to be carried out for each dimension group.

4) Tests to be carried out on one, at random chosen, diameter per dimension group.

5) To be performed: 1.000h reference pressure test for pipes.


7) To be performed: B.2, B.4, B.5, MFR of table B.1, 1.000h pressure test of table B.2.

8) To be performed: C.2, 1h and 1.000h pressure test acc. C3, table C.3 excl. thermal stability, C.5.

9) To be performed: D.2, 1h and 1.000h pressure test acc. D3, table D.2 excl. thermal stability, D.5.
10) To be performed: MFR of table E.1, E.2, 1h and 1.000h pressure test acc. E.3, table E.3 excl. thermal stability
11) To be performed: F.2, 1h and 1.000h pressure test acc. F.3, F.4
12) To be performed: G.2, 1h and 1.000h pressure test acc. G.3, G.4, G.5
13) To be performed: H.1.2 excl. thermal stability, H.2, 1h and 1.000h acc. H.4, H.5 excl. thermal stability
14) To be performed: J.2, J.3, J.4
15) To be performed: K.2 and K.3 excl. thermal stability

6.2 Inspection of the quality system
During the inspection visits the Kiwa inspector checks the internal quality system by verifying the IQC scheme.
7 Agreements on the implementation of certification

7.1 General
Beside the requirements included in this evaluation guideline, also the general rules for certification as included in the Kiwa Regulations for Product Certification apply.

These rules are in particular
- The general rules for conducting the precertification tests, to be distinguished in:
  - the way suppliers are to be informed about how an application is being handled;
  - how the test are conducted;
  - the decision to be taken as a result of the precertification tests.
- The general directions for conducting inspections and the aspects to be audited;
- The measurements to be taken by Kiwa in case of Non Conformities;
- Measurements taken by Kiwa in case of improper Use of Certificates, Certification Marks, Pictograms and Logos;
- Terms for termination of the certificate;
- The possibility to appeal to decisions of measurements taken by Kiwa.

7.2 Certification staff
The staff involved in the certification may be sub-divided into:
- certification experts: they are in charge of carrying out the precertification tests and assessing the inspectors’ reports;
- inspectors: they are in charge of carrying out external inspections at the supplier’s works;
- decision-makers: they are in charge of taking decisions in connection with the precertification tests carried out, continuing the certification in connection with the inspections carried out and taking decisions with respect to corrective actions;
- qualified material experts: they are in charge of the set up of the program and the evaluation of the precertification tests.
7.2.1 Qualification requirements

The following qualification requirements have been set by the Board of Experts for the subject matter of this Evaluation Guideline:

<table>
<thead>
<tr>
<th>EN45011</th>
<th>Certification Expert</th>
<th>Inspector</th>
<th>Decision maker</th>
<th>Qualified Material Expert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education - general</td>
<td>• Technical higher-level professional education</td>
<td>• Intermediate-level professional education</td>
<td>• Higher level professional education</td>
<td>• Higher level professional education</td>
</tr>
<tr>
<td></td>
<td>• Internal training certification and Kiwa policy</td>
<td>• Internal training certification and Kiwa policy</td>
<td>• Internal training certification and Kiwa policy</td>
<td>• Training auditing</td>
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<td></td>
<td>• Training auditing</td>
<td>• Training auditing</td>
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<td>• Training auditing</td>
</tr>
<tr>
<td>Education - specific</td>
<td>• for evaluation guideline relevant technical education specific studies and training (know-how and skills)</td>
<td>• for evaluation guideline relevant technical education specific studies and training (know-how and skills)</td>
<td>• not applicable</td>
<td>• training and education in rubber technology</td>
</tr>
<tr>
<td>Experience - general</td>
<td>• 1 year of relevant work experience with at least 4 precertification tests of which one carried out independent under supervision.</td>
<td>• 1 year of relevant work experience with at least 4 inspections of which one carried out independent under supervision.</td>
<td>• 4 year of relevant work experience with at least 1 year in certification</td>
<td>• 5 year of relevant work experience</td>
</tr>
</tbody>
</table>
| Experience - specific | • Detailed knowledge of the evaluation guideline and 4 certification tests carried out on the basis of the guideline or one related. | • Detailed knowledge of the evaluation guideline and 4 inspections carried out on the basis of the guideline or one related. | • general knowledge of the evaluation guideline | • Detailed knowledge of the evaluation guideline

The level of education and the experience of the certification staff involved should be demonstrably recorded.

7.2.2 Qualification

The qualification of the Certification staff shall be demonstrated by means of assessing the education and experience to the requirements mentioned before. In case staff is to be qualified on the basis of deflecting criteria, written records shall be kept. The authority to qualify staff is dedicated to:

- decision makers: qualification of certification experts, inspectors and qualified material experts;
- Management of Kiwa: qualification of decision makers.

7.3 Report Precertification tests

Kiwa records the results of the precertification tests in a report. This report shall comply with the following requirements:

- completeness: the reports verdicts about all requirements included in the evaluation guideline;
- traceability: the findings on which the verdicts have been based shall be recorded traceable;
- basis for decision: the decision maker shall be able to base his decision on the findings included in the report.
7.4 Decision for granting the certificate
The decision for granting the certificate shall be made by a qualified decision maker which has not been involved in the precertification tests. The decision shall be recorded traceable.

7.5 Lay out of quality declaration
The product certificate shall be conform the model included as an annex

7.6 Nature and frequency of external inspections
The certification body shall carry out Audits at the supplier at regular intervals to check whether the supplier complies with his obligations. About the frequency of inspections the Board of Experts decides. At the time this Evaluation Guideline took effect, the frequency was set at number of four inspection visits per year.

Inspections shall at least refer to:
• The supplier’s IQC-scheme and the results obtained from inspections carried out by the supplier;
• The correct way of marking of certified products;
• Complying with required procedures.

The results of each inspection shall be traceable recorded in a report.

7.7 Interpretation of requirements
The Board of Experts may record the interpretation of requirements of these evaluation guidelines in one separate interpretation document.
8 List of documents stated

8.1 Rules by public law

8.2 Norms / normative documents:

BRL-K903 Guideline for the KIWA Process Certificate Admission Scheme Installers of Tankinstallations (REIT)

BRL-K17101 PE piping systems with an aluminium barrier layer for the transport of drinking water in polluted soil

EN 743 Plastics piping and ducting systems - Thermoplastics pipes - Determination of the longitudinal reversion

EN 921 Plastics piping systems - Thermoplastics pipes - Determination of resistance to internal pressure at constant temperature

EN 10088-1 Stainless steels - Part 1: List of stainless steels

EN 45011 General criteria for certification bodies operating product certification

EN-ISO 1133 Determination of the melt mass flow rate (MFR) and the melt volume (MVR) of thermoplastics


EN-ISO 15874 Plastics piping systems for hot and cold water installations - Polypropylene (PP)

EN-ISO 15875 Plastics piping systems for hot and cold water installations - Crosslinked polyethylene (PE-X)

EN ISO 15876 Plastics piping systems for hot and cold water installations - Polybutylene (PB)

EN ISO 15877 Plastics piping systems for hot and cold water installations - Chlorinated polyvinyl chloride (PVC-C)

ISO 3 Preferred numbers - Series of preferred numbers

ISO 161-1 Thermoplastics pipes for the conveyance of fluids — Nominal outside diameters and nominal pressures — Part 1: Metric series

ISO 2165 Pipes and fittings of plastics materials — Fittings for domestic and industrial waste pipes - Basic dimensions

ISO 306 Plastics — Thermoplastics materials — Determination of Vicat softening temperature (VST)

ISO 472 Plastics — Vocabulary

ISO 1043-1 Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics

ISO 1183 Thermoplastics pipes — Longitudinal reversion — Part 1: Determination methods

ISO 2505-1 Thermoplastics pipes — Longitudinal reversion — Part 1: Determination methods

ISO 2505-2 Thermoplastics pipes — Longitudinal reversion — Part 2: Determination parameters

ISO 2507-1 Thermoplastics pipes and fittings — Vicat softening temperature — Part 1: General test method

ISO 2507-2 Thermoplastics pipes and fittings — Vicat softening temperature — Part 2: Test conditions

ISO 3126 Plastics piping systems — Plastics components — Determination of dimensions

ISO 6964 Polylefin pipes and fittings — Determination of carbon black content by calcination and pyrolysis — Test method and basic specification

ISO 9080 Plastics piping and ducting systems — Determination of long-term hydrostatic strength of thermoplastics material in pipe form by extrapolation

ISO 9852 PVC-U pipes — Dichloromethane resistance at specified temperature (DCMT) — Test method
<table>
<thead>
<tr>
<th>Standard Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 11357-6</td>
<td>Plastics -- Differential scanning calorimetry (DSC) -- Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)</td>
</tr>
<tr>
<td>ISO 10931</td>
<td>Plastics piping for industrial applications - PVDF - specifications for components</td>
</tr>
<tr>
<td>ISO 12092</td>
<td>Fittings, valves and other piping components made of PVC-U, PVC-C, ABS and ASA for pipes under pressure - resistance to internal pressure - test method</td>
</tr>
<tr>
<td>ISO 15493</td>
<td>Plastics piping for industrial applications - ABS, PVC-U, PVC-C - specifications for components</td>
</tr>
<tr>
<td>ISO 15494</td>
<td>Plastics piping for industrial applications - PB, PE, PP - specifications for components and the system - metric series</td>
</tr>
<tr>
<td>ISO 15853</td>
<td>Thermoplastics materials – Preparation of tubular test pieces for the determination of the hydrostatic strength of materials used for injection moulding</td>
</tr>
<tr>
<td>ISO 22391 series</td>
<td>Plastic piping systems for hot and cold water installations- Poly ethylene of raised temperature resistance (PE-RT)</td>
</tr>
<tr>
<td>DIBt Medienlisten 40</td>
<td>Medienlisten 40 für Behälter, Auffangvorrichtungen und Rohre aus Kunststoff</td>
</tr>
</tbody>
</table>
Annex A

Polybutene (PB)

A.1 Material characteristics

A.1.1 Hydrostatic strength properties
The material for pipes and fittings shall be evaluated in accordance with EN ISO 9080 or equivalent where internal pressure tests are made in accordance with EN-ISO 1167 to find the $s_{LPL}$-values. The $s_{LPL}$-values thus determined shall at least be as high as the corresponding values of the reference curves according ISO 15494, Annex A, par. A.1.1.

A.1.2 Other characteristics of the pipe and fitting material
The material from which the pipes and fittings are manufactured shall conform to the requirements given in table A.1.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement $^a$</th>
<th>Test parameters</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melt mass-flow rate (MFR)</td>
<td>MFR $\leq$ 3.0 g/10 min</td>
<td>Temperature Load</td>
<td>190 °C 5 kg</td>
</tr>
</tbody>
</table>

$^a$ Conformity to this requirement shall be declared by the raw-material producer.

A.1.3 Other characteristics of the fitting material
When testing the thermal stability of the fitting material by hydrostatic pressure testing in accordance with EN 921:1994 at 110 °C for 8760 h, using a test piece in pipe form or a fitting connected to pipes, the test piece shall withstand the test without bursting. The test shall be conducted in water-in-air at an internal pressure equivalent to the hydrostatic stress used in the pipe material thermal stability test.
If a fitting connected to pipes is used as a test piece and the pipe connection fails then the thermal stability test shall be repeated using a test piece in pipe form.

A.1.4 Crystallization
Due to the slow crystallization and shrinkage which takes place after PB has been cooled from the molten plate, physical and mechanical testing shall be delayed after extrusion or moulding for a period of at least 10 days at a temperature of $(20 \pm 5)$ °C.

A.2 Geometrical characteristics
The diameters, wall thicknesses and associated tolerances of the pipes and fittings shall conform to the own specifications of the manufacturer. These specifications are laid down between the manufacturer and Kiwa (e.g. in technical drawings), in an annex to the IQC-schedule (see annex VI).

A.3 Mechanical characteristics of fittings
When tested in accordance with the test method as specified in table A.2 using the indicated parameters, the fittings shall withstand the hydrostatic (hoop) stress without bursting.
### Table A.2 – Requirements for internal-pressure testing

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters for the individual tests</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hydrostatic hoop stress</td>
<td>Test temp. °C</td>
</tr>
<tr>
<td>Resistance to internal pressure</td>
<td>No failure during test period</td>
<td>MPa</td>
<td>≥1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15,5</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6,2</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6,0</td>
<td>95</td>
</tr>
</tbody>
</table>

**Test parameters for all tests**
- Type of end cap
- Orientation of test piece
- Conditioning time
- Type of test

Type a) as specified in ISO 1167
- Not specified
- ≥ 1 h
- Water-in-water

)a) Fittings shall be prepared in accordance with ISO 12092 and tested in accordance with ISO 1167

### A.4 Physical characteristics of P-, M- and F-pipes

When tested in accordance with the test methods as specified in table A.3 using the indicated parameters, the pipes shall conform to the requirements given in this table.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal reversion, on complete pipe</td>
<td>≤ 2 % The pipe shall exhibit no bubbles or cracks</td>
<td>Temperature Duration of exposure for:</td>
<td>110 °C Method B of EN 743 (oven test)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e ≤ 8 mm</td>
<td>60 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8 mm &lt; e ≤ 16 mm</td>
<td>120 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e &gt; 16 mm</td>
<td>240 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Length of test pieces</td>
<td>200 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of test pieces</td>
<td>3</td>
</tr>
<tr>
<td>Thermal stability by hydrostatic pressure, on stress-designed polymeric layer</td>
<td>No bursting during the test period</td>
<td>End cap Orientation Type of test Hydrostatic (hoop) stress Test temperature Test period Number of test pieces</td>
<td>Type a) Free Water-in-air 2,4 MPa 110 °C 8760 h 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test method</td>
<td>ISO 1167</td>
</tr>
<tr>
<td>Melt mass-flow rate (MFR), on stress-designed polymeric layer</td>
<td>0,3 g/10 min in maximum difference compared to compound</td>
<td>Temperature Load Test period Number of test pieces</td>
<td>190 °C 5 kg 10 min 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test method</td>
<td>ISO 1133</td>
</tr>
</tbody>
</table>

### A.5 Physical characteristics of fittings

The melt flow rate (MFR) of the compound and the injection-moulded fitting made therefrom shall be determined in accordance with the procedures given in ISO 1133 using the temperature and the criteria appropriate to the material involved. The difference between the MFR of the injection-moulded material and the MFR of the original compound shall be determined.

For PB compounds and injection-moulded products of the same compound, the set of conditions T (190/5) of ISO 1133 shall be used and the difference between the MFR values shall not be greater than 0,3 g/10 min.
Annex B

Polyethylene (PE)

B.1 Material characteristics
This annex is applicable to the following types of polyethylene:
- PE 63 polyethylene;
- PE 80 polyethylene;
- PE 100 polyethylene.

B.1.1 Hydrostatic strength properties
The material for pipes and fittings shall be evaluated in accordance with EN ISO 9080 or equivalent where internal pressure tests are made in accordance with EN-ISO 1167 to find the $\sigma_{\text{LPL}}$-values. The $\sigma_{\text{LPL}}$-values thus determined shall at least be as high as the corresponding values of the reference curves according ISO 15494, Annex B, par. B.1.2.

B.1.2 Other characteristics of the material
The material from which the components are manufactured shall conform to the requirements given in table B.1.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>$\geq 930 , \text{kg/m}^3$ (base polymer)</td>
<td>Test temperature 23 °C</td>
<td>ISO 1183, method D</td>
</tr>
<tr>
<td>Thermal stability</td>
<td>OIT $\geq 20$ min</td>
<td>Test temperature 200 °C b</td>
<td>ISO/TR 10837</td>
</tr>
<tr>
<td>Carbon black content c</td>
<td>2,0% to 2,5% by mass</td>
<td>As specified in ISO 6964</td>
<td>ISO 6964</td>
</tr>
<tr>
<td>Melt mass-flow rate (MFR)</td>
<td>$0.2 \leq \text{MFR} \leq 1.7$ g/10 min</td>
<td>Temperature Load 190 °C 5 kg</td>
<td>ISO 1133</td>
</tr>
</tbody>
</table>

---

a) Conformity to this requirement shall be declared by the raw-material producer.
b) Test may be carried out at 210 °C, providing there is a clear correlation with the results at 200 °C. In cases of dispute, the test shall be carried out at 200 °C.
c) Only for black material.

B.2 Geometrical characteristics
The diameters, wall thicknesses and associated tolerances of the pipes and fittings shall conform to the own specifications of the manufacturer. These specifications are laid down between the manufacturer and Kiwa (e.g. in technical drawings), in an annex to the IQC-schedule (see annex VI).

B.3 Mechanical characteristics of fittings
When tested in accordance with the test methods as specified in table B.2 using the indicated parameters, the fittings shall withstand the hydrostatic (hoop) stress without bursting.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters for the individual tests</th>
<th>Test method&lt;sup&gt;a)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance to internal pressure at 20 °C</td>
<td>No failure during test period</td>
<td>Material</td>
<td>Hydrostatic hoop stress</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MPa</td>
<td>h</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PE 63</td>
<td>8,0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PE 80</td>
<td>10,0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PE 100</td>
<td>12,4</td>
</tr>
</tbody>
</table>

| Resistance to internal pressure at 80 °C | No failure during test period                    | Material | Hydrostatic hoop stress | Test period | Number of test pieces |
|-----------------------------------------|-------------------------------------------------|-----------------------------------------|-------------------------|
|                                         | Material                                         | MPa | h                          |                          |                          |
|                                         | PE 63                                             | 3,5 | > 165<sup>b</sup>       | 3                        |
|                                         | PE 80                                             | 4,5 | > 165<sup>b</sup>       | 3                        |
|                                         | PE 100                                            | 5,4 | > 165<sup>b</sup>       | 3                        |

| Resistance to internal pressure at 80 °C | No failure during test period                    | Material | Hydrostatic hoop stress | Test period | Number of test pieces |
|-----------------------------------------|-------------------------------------------------|-----------------------------------------|-------------------------|
|                                         | Material                                         | MPa | h                          |                          |                          |
|                                         | PE 63                                             | 3,2 | ≥ 1000                     | 3                        |
|                                         | PE 80                                             | 4,0 | ≥ 1000                     | 3                        |
|                                         | PE 100                                            | 5,0 | ≥ 1000                     | 3                        |

<sup>a)</sup> Fittings shall be prepared in accordance with ISO 12092 and tested in accordance with ISO 1167

<sup>b)</sup> Only brittle fracture shall be taken into account. If a ductile failure occurs before the required minimum time, a lower stress shall be selected and the minimum test time taken from the stress/time points given in table B.3

Table B.3 – Hydrostatic (hoop) stress at 80 °C – Stress/time requirements in the case of ductile failure

<table>
<thead>
<tr>
<th>Stress</th>
<th>Minimum test period</th>
<th>Stress</th>
<th>Minimum stress period</th>
<th>Stress</th>
<th>Minimum stress period</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPa</td>
<td>h</td>
<td>MPa</td>
<td>h</td>
<td>MPa</td>
<td>h</td>
</tr>
<tr>
<td>3,5</td>
<td>165</td>
<td>4,5</td>
<td>165</td>
<td>5,4</td>
<td>165</td>
</tr>
<tr>
<td>3,4</td>
<td>295</td>
<td>4,4</td>
<td>233</td>
<td>5,3</td>
<td>256</td>
</tr>
<tr>
<td>3,3</td>
<td>538</td>
<td>4,3</td>
<td>331</td>
<td>5,2</td>
<td>399</td>
</tr>
<tr>
<td>3,2</td>
<td>1000</td>
<td>4,2</td>
<td>474</td>
<td>5,1</td>
<td>629</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>4,1</td>
<td>685</td>
<td>5,0</td>
<td>1000</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>4,0</td>
<td>1000</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
B.4 Physical characteristics of P-, M- and F-pipes
When tested in accordance with the test methods as specified in table B.4 using the indicated parameters, the pipes shall conform to the requirements given in this table.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal reversion, on complete pipe</td>
<td>≤ 3 %</td>
<td>Temperature Duration of exposure for:</td>
<td>Method B of EN 743 (oven test)</td>
</tr>
<tr>
<td></td>
<td>The pipe shall exhibit no bubbles or cracks</td>
<td>e ≤ 8 mm 60 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8 mm &lt; e ≤ 16 mm 120 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>e &gt; 16 mm 240 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Length of test pieces 200 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of test pieces 3</td>
<td></td>
</tr>
<tr>
<td>Melt mass-flow rate (MFR), on stress-designed polymeric layer</td>
<td>When processing the material into a pipe, the MFR-value specified by the raw material producer may deviate by, at the most, ± 20% from the value for the raw material</td>
<td>Temperature Load</td>
<td>190 °C 5 kg 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of test pieces 3</td>
<td></td>
</tr>
</tbody>
</table>

B.5 Physical characteristics of fittings
The melt flow rate (MFR) of the compound and the injection-moulded fitting made therefrom shall be determined in accordance with the procedures given in ISO 1133 using the temperature and the criteria appropriate to the material involved. The difference between the MFR of the injection-moulded material and the MFR of the original compound shall be determined.

For PE compounds and injection-moulded products of the same compound, the set of conditions T (190/5) of ISO 1133 shall be used and the difference between the MFR values shall not be greater than 20 %.
Annex C

Polyethylene of raised temperature resistance (PE-RT)

C.1 Material characteristics
This annex is applicable to the following types of polyethylene of raised temperature resistance:
- PE-RT, type I;
- PE-RT, type II.

C.1.1 Hydrostatic strength properties
C.1.1.1 PE-RT pipe and fitting material
The material for pipes and fittings shall be evaluated in accordance with EN ISO 9080 or equivalent where internal pressure tests are made in accordance with EN-ISO 1167 to find the \( \sigma_{LPL} \)-values. The \( \sigma_{LPL} \)-values thus determined shall at least be as high as the corresponding values of the reference curves according ISO 22391, part 2.

C.1.2 Other characteristics of the fitting material
The thermal stability of the fitting material shall be tested by means of hydrostatic pressure testing in accordance with ISO 1167-1 and ISO 1167-2 at 110°C for 8760 h, using a test piece in pipe form or a fitting connected to pipes. The test piece shall withstand the test without bursting. The test shall be conducted in water-in-air at an internal pressure equivalent to the hydrostatic stress used in the pipe material thermal stability test. If a fitting connected to pipes is used as a test piece and the pipe connection fails, then the thermal stability test shall be repeated using a test piece in pipe form.

C.2 Geometrical characteristics
The diameters, wall thicknesses and associated tolerances of the pipes and fittings shall conform to the own specifications of the manufacturer. These specifications are laid down between the manufacturer and Kiwa (e.g. in technical drawings), in an annex to the IQC-schedule (see annex VI).

C.3 Mechanical characteristics of fittings
When tested in accordance with the test method as specified in tables C.1 and C.2 using the indicated parameters for PE-RT type I or II, the fittings shall withstand the hydrostatic (hoop) stress without bursting.
### Table C.1 – Mechanical characteristics of PE-RT Type I fittings

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters for the individual tests</th>
<th>Test method&lt;sup&gt;a)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Hydrostatic hoop stress</strong></td>
<td><strong>Test temp.</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>MPa</td>
<td>°C</td>
</tr>
<tr>
<td>Resistance to internal pressure</td>
<td>No failure during test period</td>
<td>9,9</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3,8</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3,6</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3,4</td>
<td>95</td>
</tr>
<tr>
<td><strong>Test parameters for all tests</strong></td>
<td></td>
<td>Type of end cap</td>
<td>Type a) as specified in ISO 1167</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Orientation of test piece</td>
<td>Not specified</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conditioning time</td>
<td>≥ 1 h</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type of test</td>
<td>Water-in-water</td>
</tr>
</tbody>
</table>

<sup>a)</sup> Fittings shall be prepared in accordance with ISO 12092 and tested in accordance with ISO 1167

### Table C.2 – Mechanical characteristics of PE-RT Type II fittings

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters for the individual tests</th>
<th>Test method&lt;sup&gt;a)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Hydrostatic hoop stress</strong></td>
<td><strong>Test temp.</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>MPa</td>
<td>°C</td>
</tr>
<tr>
<td>Resistance to internal pressure</td>
<td>No failure during test period</td>
<td>10,8</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3,9</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3,7</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3,6</td>
<td>95</td>
</tr>
<tr>
<td><strong>Test parameters for all tests</strong></td>
<td></td>
<td>Type of end cap</td>
<td>Type a) as specified in ISO 1167</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Orientation of test piece</td>
<td>Not specified</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conditioning time</td>
<td>≥ 1 h</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type of test</td>
<td>Water-in-water</td>
</tr>
</tbody>
</table>

<sup>a)</sup> Fittings shall be prepared in accordance with ISO 12092 and tested in accordance with ISO 1167

### C.4 Physical characteristics of P-, M- and F-pipes

When tested in accordance with the test methods as specified in table C.3 using the indicated parameters for PE-RT type I or II, the pipes shall conform to the requirements given in this table.
Table C.3 – Physical characteristics of P-, M- and F-pipes

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal reversion, on complete pipe</td>
<td>≤ 2 % The pipe shall exhibit no bubbles or cracks</td>
<td>Temperature Duration of exposure for: e ≤ 8 mm 8 mm &lt; e ≤ 16 mm e &gt; 16 mm Number of test pieces</td>
<td>ISO 2505</td>
</tr>
<tr>
<td></td>
<td></td>
<td>110 °C 60 min 120 min 240 min 3</td>
<td></td>
</tr>
<tr>
<td>Thermal stability by hydrostatic pressure testing, on stress-designed polymeric layer</td>
<td>No bursting during the test period</td>
<td>End cap Orientation Type of test Hydrostatic (hoop) stress Test temperature Test period Number of test pieces</td>
<td>ISO 1167</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type a) Free Water-in-air Type I: 1,9 MPa Type II: 2,3 MPa 110 °C 8760 h 1</td>
<td></td>
</tr>
<tr>
<td>Melt mass-flow rate (MFR), on stress-designed polymeric layer</td>
<td>30% maximum difference compared to compound</td>
<td>Temperature Load Test period Number of test pieces</td>
<td>ISO 1133</td>
</tr>
<tr>
<td></td>
<td></td>
<td>190 °C 5 kg 10 min 3</td>
<td></td>
</tr>
</tbody>
</table>

C.5 Physical characteristics of fittings

The melt mass flow rate (MFR) of the compound and the injection-moulded fitting made there from shall be determined in accordance with ISO 1133, using the temperature and force criteria appropriate to the material. The difference between the MFR of the injection-moulded material taken from the fitting and the MFR of the original compound shall be determined.

For PE-RT compounds and injection-moulded products of the same compound, conditions T (190/5) according to ISO 1133 shall be used: the difference between the MFR values shall not be greater than 30 %.
Annex D

Crosslinked polyethylene (PE-X)

D.1 Material characteristics
The material from which the pipes are made shall be polyethylene (PE) which is crosslinked
during or after the manufacturing of the pipe.
In any case the pipe shall be fully crosslinked before leaving the factory.

The material may be crosslinked by any process (peroxide, silane, electron beam and azo)
which changes the chemical structure in such a way that the polymer chains are connected
with each other to a three-dimensional net by chemical bonds.

D.1.1 Hydrostatic strength properties

D.1.1.1 PE-X pipes and fittings
The material for pipes and fittings shall be evaluated in accordance with EN ISO 9080 or
equivalent where internal pressure tests are made in accordance with EN-ISO 1167 to find the
\( \sigma_{LPL} \)-values. The \( \sigma_{LPL} \)-values thus determined shall at least be as high as the corresponding
values of the reference curves according ISO 15875, part 2.

Where fittings are manufactured from the same material as pipes, the material classification
shall be the same as for pipes.

D.1.2 Other characteristics of the fitting material
When testing the thermal stability by hydrostatic pressure testing in accordance with
EN 921:1994 at 110 °C for 8760 h, using a test piece in pipe form or a fitting connected to pipes,
the test piece shall withstand the test without bursting. The test shall be conducted in water-in-
air at an internal pressure equivalent to the hydrostatic stress used in the pipe material thermal
stability test.
If a fitting connected to pipes is used as a test piece and the pipe connection fails then the
thermal stability test shall be repeated using a test piece in pipe form.

D.2 Geometrical characteristics
The diameters, wall thicknesses and associated tolerances of the pipes and fittings shall
conform to the own specifications of the manufacturer. These specifications are laid down
between the manufacturer and Kiwa (e.g. in technical drawings), in an annex to the IQC-
schedule (see annex VI).

D.3 Mechanical characteristics of fittings
When tested in accordance with the test method as specified in table D.1 using the indicated
parameters, the fittings shall withstand the hydrostatic (hoop) stress without bursting.
Table D.1 – Mechanical characteristics of fittings

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters for the individual tests</th>
<th>Test method&lt;sup&gt;a)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance to internal pressure</td>
<td>No failure during test period</td>
<td>Hydrostatic hoop stress</td>
<td>Test temp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MPa</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12,0</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4,8</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4,7</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4,6</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4,4</td>
<td>95</td>
</tr>
</tbody>
</table>

Test parameters for all tests

<table>
<thead>
<tr>
<th>Type of end cap</th>
<th>Orientation of test piece</th>
<th>Conditioning time</th>
<th>Type of test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type a) as specified in ISO 1167</td>
<td>Not specified</td>
<td>≥ 1 h</td>
<td>Water-in-water</td>
</tr>
</tbody>
</table>

<sup>a)</sup> Fittings shall be prepared in accordance with ISO 12092 and tested in accordance with ISO 1167

D.4 Physical characteristics P-, M- and F-pipes
When tested in accordance with the test methods as specified in table D.2 using the indicated parameters, the pipes shall conform to the requirements given in this table.

Table D.2 – Physical characteristics of P-, M- and F-pipes

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal reversion, on complete pipe</td>
<td>≤ 3 % The pipe shall exhibit no bubbles or cracks</td>
<td>Temperature</td>
<td>Method B of EN 743:1994 (oven test)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Duration of exposure for:</td>
<td>ISO 1167</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e ≤ 8 mm</td>
<td>60 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8 mm &lt; e ≤ 16 mm</td>
<td>120 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e &gt; 16 mm</td>
<td>240 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of test pieces</td>
<td>3</td>
</tr>
<tr>
<td>Thermal stability by hydrostatic pressure testing, on stress-designed polymeric layer</td>
<td>No bursting during the test period</td>
<td>End cap</td>
<td>Type a) as specified in ISO 1167</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Orientation</td>
<td>Free</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type of test</td>
<td>Water-in-air</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydrostatic (hoop) stress</td>
<td>2,5 MPa</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test temperature</td>
<td>110 °C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test period</td>
<td>8760 h</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of test pieces</td>
<td>1</td>
</tr>
<tr>
<td>Crosslinking, on stress-designed layer</td>
<td>≥ 70 % ≥ 65 % ≥ 60 % ≥ 60 %</td>
<td>Shall conform to EN 579</td>
<td>EN 579</td>
</tr>
<tr>
<td>- peroxide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- silan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- electron beam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- azo</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

D.5 Physical characteristics of fittings
When determined in accordance with EN 579, the degree of crosslinking of injection moulded fittings made from crosslinked polyethylene shall conform to table D.3.

Table D.3 - Degree of crosslinking

<table>
<thead>
<tr>
<th>Crosslinking process</th>
<th>Degree of crosslinking</th>
</tr>
</thead>
<tbody>
<tr>
<td>- peroxide</td>
<td>≥ 70 %</td>
</tr>
<tr>
<td>- silan</td>
<td>≥ 65 %</td>
</tr>
<tr>
<td>- electron beam</td>
<td>≥ 60 %</td>
</tr>
<tr>
<td>- azo</td>
<td>≥ 60 %</td>
</tr>
</tbody>
</table>
Annex E

Polypropylene (PP)

E.1 Material characteristics
This annex is applicable to the following types of polypropylene:
- Polypropylene homopolymer (PP-H);
- Polypropylene block-copolymer (PP-B);
- Polypropylene random-copolymer (PP-R).

E.1.1 Hydrostatic strength properties
The material for pipes and fittings shall be evaluated in accordance with EN ISO 9080 or equivalent where internal pressure tests are made in accordance with EN-ISO 1167 to find the $\sigma_{LPL}$-values. The $\sigma_{LPL}$-values thus determined shall at least be as high as the corresponding values of the reference curves according ISO 15494, Annex C, par. C.1.2.

E.1.2 Other characteristics of the pipe and fitting material
The material from which the components are manufactured shall conform to the requirements given in table E.1.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charpy impact strength</td>
<td>PP-H &gt; 7 KJ/m²</td>
<td>Test temperature</td>
<td>23 °C Notched ISO 179-2 Method: ISO 179-2/1eA</td>
</tr>
<tr>
<td></td>
<td>PP-B &gt; 25 KJ/m²</td>
<td>Test piece</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PP-R &gt; 25 KJ/m²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melt mass-flow rate (MFR)</td>
<td>(0,18 ≤ MFR ≤ 0,4) g/10 min</td>
<td>Temperature Load</td>
<td>230 °C 2,16 kg ISO 1133</td>
</tr>
</tbody>
</table>

a) Conformity to this requirement shall be declared by the raw-material producer.

E.1.3 Other characteristics of the fitting material
When testing the thermal stability of the fitting material by hydrostatic pressure testing in accordance with EN 921:1994 at 110 °C for 8760 h, using a test piece in pipe form or a fitting connected to pipes, the test piece shall withstand the test without bursting. The test shall be conducted in water-in-air at an internal pressure equivalent to the hydrostatic stress used in the pipe material thermal stability test.
If a fitting connected to pipes is used as a test piece and the pipe connection fails then the thermal stability test shall be repeated using a test piece in pipe form.

E.2 Geometrical characteristics
The diameters, wall thicknesses and associated tolerances of the pipes and fittings shall conform to the own specifications of the manufacturer. These specifications are laid down between the manufacturer and Kiwa (e.g. in technical drawings), in an annex to the IQC-schedule (see annex VI).

E.3 Mechanical characteristics of fittings
When tested in accordance with the test method as specified in table E.2 using the indicated parameters, the fittings shall withstand the hydrostatic (hoop) stress without bursting.
### Table E.2 – Requirements for internal-pressure testing

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters for the individual tests</th>
<th>Test method&lt;sup&gt;a)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Resistance to internal pressure at 20 °C</strong></td>
<td>No failure during test period</td>
<td>Material</td>
<td>Hydrostatic hoop stress</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MPa</td>
<td>h</td>
</tr>
<tr>
<td>PP-H</td>
<td>21,0</td>
<td>≥ 1</td>
<td>3</td>
</tr>
<tr>
<td>PP-B</td>
<td>16,0</td>
<td>≥ 1</td>
<td>3</td>
</tr>
<tr>
<td>PP-R</td>
<td>16,0</td>
<td>≥ 1</td>
<td>3</td>
</tr>
<tr>
<td><strong>Resistance to internal pressure at 95 °C</strong></td>
<td>No failure during test period</td>
<td>Material</td>
<td>Hydrostatic hoop stress</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MPa</td>
<td>H</td>
</tr>
<tr>
<td>PP-H</td>
<td>4,2</td>
<td>≥ 165</td>
<td>3</td>
</tr>
<tr>
<td>PP-B</td>
<td>3,0</td>
<td>≥ 165</td>
<td>3</td>
</tr>
<tr>
<td>PP-R</td>
<td>3,8</td>
<td>≥ 165</td>
<td>3</td>
</tr>
<tr>
<td><strong>Resistance to internal pressure at 95 °C</strong></td>
<td>No failure during test period</td>
<td>Material</td>
<td>Hydrostatic hoop stress</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MPa</td>
<td>H</td>
</tr>
<tr>
<td>PP-H</td>
<td>3,5</td>
<td>≥ 1000</td>
<td>3</td>
</tr>
<tr>
<td>PP-B</td>
<td>2,6</td>
<td>≥ 1000</td>
<td>3</td>
</tr>
<tr>
<td>PP-R</td>
<td>3,5</td>
<td>≥ 1000</td>
<td>3</td>
</tr>
</tbody>
</table>

**Test parameters for all tests**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters for the individual tests</th>
<th>Test method&lt;sup&gt;a)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of end cap</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Orientation of test piece</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Conditioning time</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type of test</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>) Fittings shall be prepared in accordance with ISO 12092 and tested in accordance with ISO 1167

### E.4 Physical characteristics of P-, M- and F-pipes

When tested in accordance with the test methods as specified in table E.3 using the indicated parameters, the pipes shall conform to the requirements given in this table.
Table E.3 – Physical characteristics of P-, M- and F-pipes

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal reversion, on complete pipe</td>
<td>≤ 3 %</td>
<td>Temperature Duration of exposure for: e ≤ 16 mm e &gt; 16 mm Length of test pieces Number of test pieces</td>
<td>Method B of EN 743 (oven test)</td>
</tr>
<tr>
<td>For PP-H and PP-B</td>
<td>The pipe shall exhibit no bubbles or cracks</td>
<td>150 °C 60 min 120 min 200 mm 3</td>
<td></td>
</tr>
<tr>
<td>Longitudinal reversion, on complete pipe</td>
<td>≤ 3 %</td>
<td>Temperature Duration of exposure for: e ≤ 16 mm e &gt; 16 mm Length of test pieces Number of test pieces</td>
<td>Method B of EN 743 (oven test)</td>
</tr>
<tr>
<td>For PP-R</td>
<td>The pipe shall exhibit no bubbles or cracks</td>
<td>135 °C 60 min 120 min 200 mm 3</td>
<td></td>
</tr>
<tr>
<td>Thermal stability by hydrostatic pressure testing, on stress-designed polymeric layer</td>
<td>No bursting during the test period</td>
<td>End cap Orientation Type of test Hydrostatic (hoop) stress: PP-H PP-B PP-R Test temperature Test period Number of test pieces</td>
<td>Type a) Free Water-in-air 1,9 MPa 1,4 MPa 1,9 MPa 110 °C 8760 h 3</td>
</tr>
<tr>
<td>Impact resistance, on complete pipe</td>
<td>&lt; 10 %</td>
<td>Test temperature Test period Number of test pieces</td>
<td>ISO 9854</td>
</tr>
<tr>
<td>For PP-H</td>
<td>23°C 0 °C 0 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For PP-B</td>
<td>23°C 0 °C 0 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For PP-R</td>
<td>23°C 0 °C 0 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melt mass-flow rate (MFR), on stress-designed polymeric layer</td>
<td>When processing the material into a pipe, the MFR-value specified by the raw material producer may deviate by, at the most, + 30% from the value for the raw material</td>
<td>Temperature Load Number of test pieces</td>
<td>ISO 1133</td>
</tr>
<tr>
<td></td>
<td></td>
<td>230 °C 2,16 kg 3</td>
<td></td>
</tr>
</tbody>
</table>

E.5 Physical characteristics of fittings
The melt flow rate (MFR) of the compound and the injection-moulded fitting made therefrom shall be determined in accordance with the procedures given in ISO 1133 using the temperature and the criteria appropriate to the material involved. The difference between the MFR of the injection-moulded material and the MFR of the original compound shall be determined.

For PP compounds and injection-moulded products of the same compound set of conditions M (230/2,16) of ISO 1133:1997 shall be used and the difference between the MFR values shall not be greater than 30 %.
Annex F

Acrylonitrile-butadiene-styrene (ABS)

F.1 Material characteristics

F.1.1 Hydrostatic strength properties
The material for pipes and fittings shall be evaluated in accordance with EN ISO 9080 or equivalent where internal pressure tests are made in accordance with EN-ISO 1167 to find the $\sigma_{LPL}$-values. The $\sigma_{LPL}$-values thus determined shall at least be as high as the corresponding values of the reference curves according ISO 15493, Annex A, par. A.1.1.

F.1.2 Other characteristics of the material
The material from which the components are manufactured shall conform to the requirements given in table F.1.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement a)</th>
<th>Test temperature</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density, $\rho$ (kg/m$^3$)</td>
<td>$1000 &lt; \rho \leq 1070$</td>
<td>$23^\circ C$</td>
<td>ISO 1183-2</td>
</tr>
</tbody>
</table>

a) Conformity to this requirement shall be declared by the raw-material producer

F.2 Geometrical characteristics
The diameters, wall thicknesses and associated tolerances of the pipes and fittings shall conform to the own specifications of the manufacturer. These specifications are laid down between the manufacturer and Kiwa (e.g. in technical drawings), in an annex to the IQC-schedule (see annex VI).

F.3 Mechanical characteristics of fittings
When tested in accordance with the test method as specified in table F.2 using the indicated parameters, the fittings shall withstand the hydrostatic (hoop) stress without bursting.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Temperature</th>
<th>Hydrostatic hoop stress</th>
<th>Test period</th>
<th>Number of test pieces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance to internal pressure</td>
<td>No failure during test period</td>
<td>$20^\circ C$</td>
<td>25.0</td>
<td>$\geq 1$</td>
<td>3</td>
</tr>
<tr>
<td>Resistance to internal pressure</td>
<td></td>
<td>$20^\circ C$</td>
<td>20.6</td>
<td>$\geq 100$</td>
<td>3</td>
</tr>
<tr>
<td>Resistance to internal pressure</td>
<td></td>
<td>$60^\circ C$</td>
<td>7.0</td>
<td>$\geq 1000$</td>
<td>3</td>
</tr>
</tbody>
</table>

a) Fittings shall be prepared in accordance with ISO 12092 and tested in accordance with ISO 1167. Test set-up:
- end caps: type A as specified in ISO 1167; orientation not specified; conditioning period $\geq 1$ h; water-in-water

F.4 Physical characteristics of P-, M- and F-pipes
When tested in accordance with the test methods as specified in table F.4 using the indicated parameters, the pipes shall conform to the requirements given in this table.
### Table F.3 – Physical characteristics of P-, M- and F-pipes

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vicat softening temperature (VST/B/50 N), on stress-designed polymeric layer</td>
<td>VST ≥ 90 °C and VST ≥ 70 °C</td>
<td>Conditioning</td>
<td>6 h in air at 80 °C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conditioning</td>
<td>16 h in air at 90 °C</td>
</tr>
<tr>
<td>Longitudinal reversion, on complete pipe</td>
<td>≤ 5 %&lt;sup&gt;a)&lt;/sup&gt;</td>
<td>Temperature</td>
<td>ISO 306</td>
</tr>
<tr>
<td></td>
<td>The pipe shall exhibit no bubbles or cracks</td>
<td>Duration of exposure for:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8 mm &lt; e ≤ 16 mm</td>
<td>e ≤ 8 mm</td>
<td>ISO 2505: Method B: air</td>
</tr>
<tr>
<td></td>
<td>e &gt; 16 mm</td>
<td>150 °C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Length of test pieces</td>
<td>60 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of test pieces</td>
<td>120 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>240 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>200 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a)</sup> For nominal outside diameters ≤ 50 mm a higher value may be found. This value shall not exceed 10 %, however.

### F.5 Physical characteristics of fittings

The requirements for Vicat softening temperature according table F.3 shall be fulfilled.
Annex G

Unplasticized polyvinyl chloride (PVC-U)

G.1 Material characteristics

G.1.1 Hydrostatic strength properties
The material for pipes and fittings shall be evaluated in accordance with EN ISO 9080 or equivalent where internal pressure tests are made in accordance with EN-ISO 1167 to find the $\sigma_{PL}$-values. The $\sigma_{PL}$-values thus determined shall at least be as high as the corresponding values of the reference curves according ISO 15493, Annex B, par. B.1.1.

G.1.2 Other characteristics of the material
The material from which the components are manufactured shall conform to the requirements given in table G.1.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement a)</th>
<th>Test temperature</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density, $r$ (kg/m$^3$)</td>
<td>$1330 &lt; r &lt; 1460$</td>
<td>23 °C</td>
<td>ISO 1183-2</td>
</tr>
</tbody>
</table>

a) Conformity to this requirement shall be declared by the raw-material producer

G.2 Geometrical characteristics
The diameters, wall thicknesses and associated tolerances of the pipes and fittings shall conform to the own specifications of the manufacturer. These specifications are laid down between the manufacturer and Kiwa (e.g. in technical drawings), in an annex to the IQC-schedule (see annex VI).

G.3 Mechanical characteristics of fittings
When tested in accordance with the test methods as specified in table G.2 using the indicated parameters, the fittings shall withstand the hydrostatic (hoop) stress without bursting.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters for the individual tests</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance to internal pressure</td>
<td>No failure during test period</td>
<td>Temperature</td>
<td>Hydrostatic hoop stress</td>
</tr>
<tr>
<td>Temperature</td>
<td>MPA</td>
<td>h</td>
<td></td>
</tr>
<tr>
<td>20 °C</td>
<td>42,0</td>
<td>≥ 1</td>
<td>3</td>
</tr>
<tr>
<td>20 °C</td>
<td>35,0</td>
<td>≥ 100</td>
<td>3</td>
</tr>
<tr>
<td>20 °C</td>
<td>32,6</td>
<td>≥ 1000</td>
<td>3</td>
</tr>
<tr>
<td>60 °C</td>
<td>10,0</td>
<td>≥ 1000</td>
<td>3</td>
</tr>
</tbody>
</table>

a) Fittings shall be prepared in accordance with ISO 12092 and tested in accordance with ISO 1167. Test set-up:
- end caps: type A as specified in ISO 1167; orientation not specified; conditioning period ≥ 1h; water-in-water

G.4 Physical characteristics of P-, M- and F-pipes
When tested in accordance with the test methods as specified in table G.3 using the indicated parameters, the pipes shall conform to the requirements given in this table.
Table G.3 – Physical characteristics of P-, M- and F-pipes

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vicat softening temperature (VST/B/50 N), on stress-designed polymeric layer</td>
<td>VST ≥ 80 °C</td>
<td>As specified in ISO 2507-2</td>
<td>ISO 2507-1</td>
</tr>
<tr>
<td>Longitudinal reversion, on complete pipe</td>
<td>≤ 5 %</td>
<td>Temperature Duration of exposure for: e ≤ 8 mm 8 mm &lt; e ≤ 16 mm e &gt; 16 mm</td>
<td>ISO 2505: Method B: air</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Length of test pieces Number of test pieces</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Temperature of bath Immersion time</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>150 °C 60 min 120 min 240 min 200 mm 3</td>
<td></td>
</tr>
<tr>
<td>Resistance to dichloromethane at specified temperature, on stress-designed polymeric layer</td>
<td>No attack at any part of surface of test piece</td>
<td>15 °C 30 min</td>
<td>ISO 9852</td>
</tr>
</tbody>
</table>

G.5 Physical characteristics of fittings

G.5.1 General
When determined in accordance with the test methods specified in table G.3, using the parameters indicated, the physical characteristics of fittings shall conform to the requirements given in table G.3.
### Table G.4 - Physical characteristics of fittings

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vicat softening temperature (VST/B/50 N)</td>
<td>VST ≥ 74 °C</td>
<td>As specified in ISO 2507-2</td>
<td>ISO 2507-1</td>
</tr>
<tr>
<td>Effects of heating</td>
<td>The fittings shall not exhibit any blisters or signs of weld-line splitting&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Temperature immersion time:</td>
<td>150 °C</td>
</tr>
<tr>
<td></td>
<td>No surface damage in the area of any injection point shall penetrate by more than 30% of the wall thickness at that point. Outside the area of any injection point, no surface damage shall occur.&lt;sup&gt;b&lt;/sup&gt;</td>
<td>e ≤ 3 mm</td>
<td>15 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 mm &lt; e ≤ 10 mm</td>
<td>30 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 mm &lt; e ≤ 20 mm</td>
<td>60 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20 mm &lt; e ≤ 30 mm</td>
<td>140 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 mm &lt; e ≤ 40 mm</td>
<td>220 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e &gt; 40 mm</td>
<td>240 mm</td>
</tr>
<tr>
<td></td>
<td>Examination of test pieces after heating</td>
<td>See G.6.2</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>The weld-line is likely to become more pronounced, but this shall not be taken as a sign of weld-line opening.

<sup>b</sup>For sprue-gating, the area of the injection point shall be calculated using a radius, R, of 0,3dn, with a maximum value of 50 mm. For fittings moulded by end-gating techniques, e.g. ring or diaphragm methods, the gating area shall be a cylindrical portion with a length, L<sub>1</sub>, of 0,3dn, with a maximum value of 50 mm (see Figure B.5). Any cracks or delamination in the wall of the fitting adjacent to the injection area, parallel to the axis of the fitting, shall not penetrate in the axial direction by more than 20% of the length L<sub>1</sub>, given above.

### G.5.2 Effects of heating - Examination of test pieces

After removal from the air oven, the test pieces shall be cut, using a razor-sharp blade, from the mouth of the socket or spigot end of the fitting over its full length and the exposed surfaces examined.

The number of cuts made on each test piece shall be as follows:

- For fittings of dn ≤ 160 mm: not less than two cuts equally spaced around the periphery of the mouth of each socket or spigot end of the fitting.
- For fittings of dn > 160 mm: not less than four cuts equally spaced around the periphery of the mouth of each socket or spigot end of the fitting.
Annex H

Chlorinated polyvinyl chloride (PVC-C)

H.1 Material characteristics
This annex is applicable to the following types of chlorinated polyvinyl chloride:
- PVC-C, type I;
- PVC-C, type II.

H.1.1 Hydrostatic strength properties
The material for pipes and fittings shall be evaluated in accordance with EN ISO 9080 or equivalent where internal pressure tests are made in accordance with EN-ISO 1167 to find the \( \sigma_{PL} \)-values. The \( \sigma_{PL} \)-values thus determined shall at least be as high as the corresponding values of the reference curves according ISO 15877, part 2 for pipes and ISO 15877, part 3 for fittings.

H.1.2 Other physical characteristics of the fitting material
The material from which the fittings are manufactured shall conform to the requirements given in table H.1 for PVC-C type I and table H.2 for PVC-C type II.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vicat softening temperature</strong> (VST/B/50 N)</td>
<td>VST ≥ 103 °C</td>
<td>Shall conform to EN 727</td>
<td>EN 727</td>
</tr>
<tr>
<td><strong>Effects of heating</strong></td>
<td>a</td>
<td>Test temperature Heating time for:</td>
<td>(150 ± 2) °C (15 ± 1) min (30 ± 1) min (60 ± 1) min 3</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>e ≤ 3 mm 3 mm &lt; e ≤ 10 mm 10 mm &lt; e ≤ 20 mm</td>
<td>Method A of ISO 580 Air oven</td>
</tr>
<tr>
<td><strong>Thermal stability by hydrostatic pressure testing</strong></td>
<td>No bursting during the test period</td>
<td>Sampling procedure End cap Orientation Diameter Free length Type of test Hydrostatic (hoop) stress Test temperature Test period Number of test pieces</td>
<td>c Types A or B Vertical ( d_0 ≤ 50 \text{ mm} ) ( l_0 ≥ 3d_0 ) Water-in-air 2,85 MPa 90 °C 17520 h 3 ISO 1167-1</td>
</tr>
</tbody>
</table>

a The fitting shall not show any crack, delamination, blister or sign of weld-line splitting.

b No surface damage in the area of any injection point shall penetrate deeper than 20 % of the wall thickness, \( e \), at any point. Outside the area of any injection point, no surface damage shall occur. For sprue gating, the area of the injection point shall be calculated using a radius \( R = 0,3d_0 \). For fittings moulded by end-gating techniques, e.g. ring or diaphragm methods, the gating area shall be a cylindrical portion with a length of \( L = 0,3 d_0 \) (see Figure 3). Any cracks or delamination in the wall of the fitting adjacent to the injection area, parallel to the axis of the fitting, shall not penetrate to a depth in axial direction of more than 20 % of the nominal diameter.

c The sampling procedure is not specified. For guidance, see ISO/TS 15877-7.
Table H.2 – Physical characteristics of PVC-C type II

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vicat softening temperature (VST/B/50 N)</td>
<td>VST ≥ 115 °C</td>
<td>Shall conform to EN 727</td>
<td>EN 727</td>
</tr>
<tr>
<td>Effects of heating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test temperature</td>
<td></td>
<td>Test temperature</td>
<td></td>
</tr>
<tr>
<td>Heating time for:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e ≤ 3 mm</td>
<td>(150 ± 2) °C</td>
<td></td>
<td>Method A of ISO 580</td>
</tr>
<tr>
<td>3 mm &lt; e ≤ 10 mm</td>
<td>(15 ± 1) min</td>
<td></td>
<td>Air oven</td>
</tr>
<tr>
<td>10 mm &lt; e ≤ 20 mm</td>
<td>(30 ± 1) min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of test pieces</td>
<td>(60 ± 1) min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal stability by hydrostatic pressure testing</td>
<td>No bursting during the test period</td>
<td>Sampling procedure</td>
<td>ISO 1167-1</td>
</tr>
<tr>
<td>End cap</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orientation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diameter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free length</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrostatic (hoop) stress</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test temperature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test period</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of test pieces</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,14 MPa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8760 h</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) The fitting shall not show any crack, delamination, blister or sign of weld-line splitting.

\(^b\) No surface damage in the area of any injection point shall penetrate deeper than 20 % of the wall thickness, \(e\), at any point. Outside the area of any injection point, no surface damage shall occur. For sprue gating, the area of the injection point shall be calculated using a radius \(R = 0,3d_n\). For fittings moulded by end-gating techniques, e.g. ring or diaphragm methods, the gating area shall be a cylindrical portion with a length of \(L = 0,3d_n\) (see Figure 3). Any cracks or delamination in the wall of the fitting adjacent to the injection area, parallel to the axis of the fitting, shall not penetrate to a depth in axial direction of more than 20 % of the nominal diameter.

\(^c\) The sampling procedure is not specified. For guidance, see ISO/TS 15877-7.

H.2 Geometrical characteristics
The diameters, wall thicknesses and associated tolerances of the pipes and fittings shall conform to the own specifications of the manufacturer. These specifications are laid down between the manufacturer and Kiwa (e.g. in technical drawings), in an annex to the IQC-schedule (see annex VI).

H.4 Mechanical characteristics of fittings
When tested in accordance with the test method specified in table H.3 or table H.4, as applicable, using the indicated parameters, the fitting shall withstand the hydrostatic (hoop) stress without bursting or leakage.
### Table H.3 – Test parameters for internal pressure testing for PVC-C type I

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters for the individual tests</th>
<th>Test parameters for all tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Temperature</td>
<td>Hydrostatic hoop stress</td>
</tr>
<tr>
<td>Resistance to internal pressure</td>
<td>No failure during test period</td>
<td>20 °C</td>
<td>43,0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95 °C</td>
<td>5,6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95 °C</td>
<td>4,6</td>
</tr>
</tbody>
</table>

### Table H.4 – Test parameters for internal pressure testing for PVC-C type II

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters for the individual tests</th>
<th>Test parameters for all tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Temperature</td>
<td>Hydrostatic hoop stress</td>
</tr>
<tr>
<td>Resistance to internal pressure</td>
<td>No failure during test period</td>
<td>20 °C</td>
<td>48,0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95 °C</td>
<td>5,9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95 °C</td>
<td>4,7</td>
</tr>
</tbody>
</table>

### H.5 Physical characteristics of P-, M- and F-pipes

When tested in accordance with the test methods specified in table H.5 or table H.6, as applicable, using the indicated parameters, the pipes shall have physical characteristics conforming to the requirements given in the applicable table.

---

**a)** The sampling procedure is not specified. For guidance see ISO/TS 15977-7.

**b)** Testing at 95 °C shall be done in water-in-air.

**c)** In case of dispute, testing at 20 °C shall be done in water-in-water.
### Table H.5 – Physical characteristics for PVC-C type I pipes

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vicat softening temperature (VST/B/50 N), on stress-designed polymeric layer</td>
<td>VST ≥ 110 °C</td>
<td>Shall conform to EN 727</td>
<td>EN 727</td>
</tr>
<tr>
<td>Longitudinal reversion, on complete pipe</td>
<td>≤ 5 % The pipe shall exhibit no bubbles or cracks</td>
<td>Test temperature Duration of exposure for: e ≤ 4 mm 4 mm &lt; e ≤ 16 mm e &gt; 16 mm Number of test pieces</td>
<td>(150 ± 2) °C  (30 ± 1) min  (60 ± 1) min  (120 ± 1) min 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ISO 2505 Air oven</td>
<td></td>
</tr>
<tr>
<td>Thermal stability by hydrostatic pressure testing, on stress-designed polymeric layer</td>
<td>No bursting during the test period</td>
<td>Sampling procedure Orientation Type of test Hydrostatic (hoop) stress Test temperature Test period Number of test pieces</td>
<td>a Types A or B Vertical Water-in-air 3.6 MPa 95 °C 8760 h 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ISO 1167-1</td>
<td></td>
</tr>
</tbody>
</table>

*The sampling procedure is not specified. For guidance, see ISO/TS 15877-7.

### Table H.6 – Physical characteristics for PVC-C type II pipes

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vicat softening temperature (VST/B/50 N), on stress-designed polymeric layer</td>
<td>VST ≥ 115 °C</td>
<td>Shall conform to EN 727</td>
<td>EN 727</td>
</tr>
<tr>
<td>Longitudinal reversion, on complete pipe</td>
<td>≤ 5 % The pipe shall exhibit no bubbles or cracks</td>
<td>Test temperature Duration of exposure for: e ≤ 4 mm 4 mm &lt; e ≤ 16 mm e &gt; 16 mm Number of test pieces</td>
<td>(150 ± 2) °C  (30 ± 1) min  (60 ± 1) min  (120 ± 1) min 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ISO 2505 Air oven</td>
<td></td>
</tr>
<tr>
<td>Thermal stability by hydrostatic pressure testing, on stress-designed polymeric layer</td>
<td>No bursting during the test period</td>
<td>Sampling procedure Orientation Type of test Hydrostatic (hoop) stress Test temperature Test period Number of test pieces</td>
<td>a Types A or B Vertical Water-in-air 2.4 MPa 100 °C 8760 h 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ISO 1167-1</td>
<td></td>
</tr>
</tbody>
</table>

*The sampling procedure is not specified. For guidance, see ISO/TS 15877-7.*
Annex J

Polyvinylidene fluoride (PVDF)

J.1 Material characteristics

J.1.1 Hydrostatic strength properties
The material for pipes and fittings shall be evaluated in accordance with EN ISO 9080 or equivalent where internal pressure tests are made in accordance with EN-ISO 1167 to find the $\sigma_{PL}$-values. The $\sigma_{PL}$-values thus determined shall at least be as high as the corresponding values of the reference curves according ISO 10931, Annex A, par. A.1.2.

J.1.2 Other characteristics of the material
The material from which the components are manufactured shall conform to the requirements of ISO 10931, par. A.1.4

J.2 Geometrical characteristics
The diameters, wall thicknesses and associated tolerances of the pipes and fittings shall conform to the own specifications of the manufacturer. These specifications are laid down between the manufacturer and Kiwa (e.g. in technical drawings), in an annex to the IQC-schedule (see annex VI).

J.3 Mechanical characteristics of fittings
When tested in accordance with the test method as specified in table J.1 using the indicated parameters, the fittings shall withstand the hydrostatic (hoop) stress without bursting.

Table J.1 – Requirements for internal-pressure testing of fittings

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters for the individual tests</th>
<th>Test method(*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance to internal</td>
<td>No failure during test period</td>
<td>Temperature MPa</td>
<td>ISO 1167</td>
</tr>
<tr>
<td>pressure</td>
<td></td>
<td>Hydrostatic hoop stress</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test period h</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of test pieces</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resistance to internal pressure</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No failure during test period</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>temperature 95 °C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>hydrostatic hoop stress 11,5 MPa</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>test period &gt; 200 h</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>number of test pieces 3</td>
<td></td>
</tr>
</tbody>
</table>

a) Fittings shall be prepared in accordance with ISO 12092 and tested in accordance with ISO 1167. Test set-up:
- end caps: type A as specified in ISO 1167; orientation not specified; conditioning period > 1h; water-in-water

J.4 Physical characteristics of P-, M- and F-pipes
When tested in accordance with the test methods as specified in table J.2 using the indicated parameters, the pipes shall conform to the requirements given in this table.

Table J.2 – Physical characteristics of M-pipes and P-pipes

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal reversion</td>
<td>$\leq 2%$ The pipe shall exhibit no bubbles or cracks</td>
<td>Temperature</td>
<td>ISO 2505:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>duration of exposure 150 °C</td>
<td>Method B:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>length of test pieces 60 min</td>
<td>air</td>
</tr>
<tr>
<td></td>
<td></td>
<td>number of test pieces 3</td>
<td></td>
</tr>
</tbody>
</table>

|                            |                                               | Temperature     | ISO 2505:   |
|                            |                                               | duration of exposure 150 °C                   | Method B:      |
|                            |                                               | length of test pieces 60 min                  | air           |
|                            |                                               | number of test pieces 3                       |              |
Annex K

Polyphenylsulfone (PPSU)

K.1 Material characteristics

K.1.1 Hydrostatic strength properties
The material for fittings shall be evaluated in accordance with EN ISO 9080 or equivalent where internal pressure tests are made in accordance with EN-ISO 1167 to find the $\sigma_{CL}$-values. The $\sigma_{CL}$-values thus determined shall at least be as high as the corresponding values of the reference curves according ISO 10931, Annex A, par. A.1.2.

K.1.2 Other characteristics of the material
No other material characteristics are defined to be relevant.

K.2 Geometrical characteristics of the fittings
The dimensions of the fittings shall be in accordance with the information (technical drawings) to be provided by the manufacturer.

K.3 Physical characteristics of fittings
When tested in accordance with the test methods as specified in table K.1 using the indicated parameters, the fitting shall conform to the requirements given in this table.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test parameters</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects on heating</td>
<td>Damage around injection point ( \leq 30% ) of wall thickness No holes, tears or other damages</td>
<td>In consultation with manufacturer</td>
<td>EN ISO 580</td>
</tr>
<tr>
<td>Thermal stability by hydrostatic pressure testing</td>
<td>No bursting during the test period</td>
<td>End cap Orientation Type of test Hydrostatic (hoop) stress Test temperature Test period Number of test pieces</td>
<td>Type a) Free Water-in-air/or water According LTHS data 90 °C 8760 h 3</td>
</tr>
</tbody>
</table>
Annex I

Determination of the resistance to chemical interactions

Principle and test method

I.0 Contents
  I.1 Introduction
  I.2 Principle of the test method
  I.3 Product Approval Range (PAR)
    I.3.1 Declaration of PAR
    I.3.2 First evaluation moment
  I.4 Test method for the pipe construction
    1.4.1 Testing procedure I
    1.4.2 Testing procedure II
    1.4.3 Testing procedure III
  I.5 Test method for the joints
  I.6 Approval of PAR

I.1 Introduction
In this annex, the principle of the test method for the determination of the resistance to chemical interactions of multilayer pipes is explained, see paragraph I.2.

The test method is described in paragraphs I.3 till I.6.

The schematic overview of the test method is included in figure I.1.

On the basis of this test method, the multilayer pipes as well as the joints have to be approved with regard to their chemical resistance for the intended chemical liquids to be transported, taking into account the intended application conditions and expected lifetime as stated by the certification applicant.

The fitting plastics material shall comply with the chemical resistance requirements according to annex I of BRL KQ-17601.

For the determination of chemical resistance of metal fittings, internationally accepted chemical resistance tables are to be consulted.

I.2 Principle of the test method
The test method shall be suitable to deal with any chemical liquid/pipe construction combination.

Therefore, 3 possible testing procedures (see par. I.4) as well as several so-called ‘evaluation moments’ are defined (see figure I.1). The interaction between the chemical and polymer nominates one of the 3 test procedures to be used. The test procedures prescribe the test method to be applied without specifying the exact test conditions.

The test conditions are depending and relating to the chemical liquid(s), declared service conditions and characteristics of the piping system. The evaluation moments help to determine the correct test procedure and test conditions.

In total 6 evaluation moments are prescribed (see figure I.1). Evaluation moments 2 till 5 deal with the assessment of test conditions. Evaluation moments 1 and 6 deal with the evaluation and confirmation of the Product Approval Range (PAR), see par. I.3.1.

Remark: The evaluations are carried out by (a) qualified person(s) under the responsibility of Kiwa.
Within the framework of certification, the applicant has to provide to Kiwa the PAR, see par. I.3.1. Hereby a first evaluation of the proposed chemical liquid/polymer combination(s) and the corresponding PAR(s) is carried out, see ‘first evaluation moment’ par. I.3.2. Also evaluated is which testing procedure has to be applied, see table I.1.

The complete multilayer pipe shall be tested in accordance with one of the three testing procedures according to table I.1.

**Table I.1. Applicable testing procedures**

<table>
<thead>
<tr>
<th>Testing procedure I</th>
<th>For chemical/polymer combinations with a chemical degradation or environmental stress cracking interaction</th>
<th>See par. I.4.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing procedure II</td>
<td>For chemical/polymer combinations whereby no interaction is expected (inert chemical liquids)</td>
<td>See par. I.4.2</td>
</tr>
<tr>
<td>Testing procedure III</td>
<td>For chemical/polymer combinations with swelling interaction</td>
<td>See par. I.4.3</td>
</tr>
</tbody>
</table>

After determination of the applicable testing procedure (see table I.1) and test conditions (evaluation moments 2, 4 or 5, see figure I.1), the chemical resistance test(s) can start.

For testing procedures I, II and III the following principles apply:
- the usage of (existing) internal pressure testing data providing lifetime predictions for the tested pipes and plastics fitting material for the transport of water (e.g. ISO 9080 or DIN 16887 internal pressure test data);
- determination of the influence (interaction) of a chemical liquid on this lifetime of the pipe/fitting material, by performing internal pressure tests with the chemical(s) concerned, whereby both the test results with water and the test results with the chemical(s) are used to calculate the new lifetime of the pipe/fitting material;
- evaluation moments at different stages of the testing procedure are determined in order to define the exact test conditions as explained above;
- the pressure tests on the pipe and fitting material (par. I.4) are ‘product tests’.

After testing procedures I, II and III separate testing of the joints shall be carried out, see par. I.5. These tests are ‘product tests’.

After testing with positive result and approval of the PAR, see par. I.6, the lifetime(s) and characteristics of the piping system in combination with the chemical liquids to be transported and the service conditions are confirmed, certified and specified in the KQ certificates issued.
Divide the chemical liquids as follows, whatever applicable:

- Into the following categories: chemical degradation and environmental stress cracking: see par. I.4.1 for testing procedure I
- ‘No interaction’ expected: see I.4.2 for testing procedure II
- Swelling interaction: see par. I.4.3 for testing procedure III

Group the liquids per category that have the same lifetime and service conditions

Perform the tests according to table I.2 for the most aggressive liquid per group. Test the other liquids in the groups at Thigh temperature.

No knee point has been detected for the chemical/plastics material combination. Confirmation of lifetime is required.

Perform the applicable pre-test and main tests according to I.4.3 for each chemical liquid.

No knee point has been detected for the chemical/plastics material combination. Confirmation of lifetime is required.

EM = evaluation moment

1) Decide whether to stop testing or e.g. continue with second aggressive liquid or change lifetime or service conditions etc. Several options are possible.
I.3 Product Approval Range (PAR)

I.3.1 Declaration of PAR
For each chemical liquid to be transported with the specified multilayer piping system, the product approval range (PAR) shall be stated by the applicant to Kiwa. On the basis of the specified PAR's, the test conditions for the pressure tests are defined. When tested with positive result, the PAR's will be declared in the KQ-certificates to be issued.

The following has to be specified by the certification applicant for defining the PAR per chemical liquid to be transported for the specified piping system:
- the intended lifetime of the piping system (years);
- the composition profile of the chemical liquid, consisting of:
  - minimum and maximum fractions of the component(s) (%);
  - possible additional components within the chemical liquid (%) and the duration of occurrence during lifetime (hours);
- the temperature profile, consisting of:
  - operational temperature ($T_{\text{oper}}$ in °C);
  - maximum temperature ($T_{\text{max}}$ in °C) and the duration of occurrence during lifetime (hours);
  - malfunction temperature ($T_{\text{mal}}$ in °C) and the duration of occurrence during lifetime (hours);
  - possible additional temperature(s) and the duration of occurrence during lifetime (hours);
- the pressure profile, consisting of:
  - operational pressure ($P_{\text{oper}}$ in bar);
  - maximum pressure ($P_{\text{max}}$ in bar);
  - possible additional pressure(s) and the duration of occurrence during lifetime (hours).

I.3.2 First evaluation moment
In order to certify the piping system, the PAR has to be approved for the chemical liquid/piping system combination. First it is assessed whether chemical resistance tests are required (with the help of e.g. the list of approved polymers/compounds, see BRL KQ 17601). If this is the case, then most of the PAR has to be verified and approved after chemical resistance testing, see par. I.6.

At the beginning of the testing procedure during the first evaluation moment (see figure I.1), the maximum pressure has to be verified as follows:
- the maximum pressure $P_{\text{max}}$ may not be higher than the pressure level of the water curve of the pipe construction and plastics fitting material at the declared lifetime of the piping system.

The following applies for the other parameters of the PAR which have to be verified and approved after chemical resistance testing, see par. I.6:
- the temperatures $T_{\text{oper}}, T_{\text{max}}$ and $T_{\text{mal}}$ shall be verified by means of extrapolation of the test results at $T_{\text{test}}$ according par. I.4;
  - in some cases a lower temperature may lead to a quicker chemical degradation than the maximum temperature and this is assessed during the evaluation moment of par. I.4.1.
- the operational pressure $P_{\text{oper}}$ shall be verified by means of extrapolation of the test results at $T_{\text{test}}$ according par. I.4;

Remark:
- testing will in principle take place at maximum declared concentration of the PAR of the chemical liquid, although:
  - in some cases a lower concentration may lead to a quicker chemical degradation than the maximum concentration and this has to be assessed during the evaluation moment of par. I.4.1.
- possible additional concentrations, temperatures and pressures as specified by the applicant (as profiles, see par. I.3.1), shall be verified and approved as well. This can
lead to different test conditions which has to be determined during the applicable evaluation moments.

Further, it shall be determined:
- which testing procedure according par. I.4 is applicable, see table I.1. Hereby, the possible by-products of the chemicals to be transported shall be taken into account also;
- which permissible degree(s) of swelling for the specific application(s) apply in case of chemical/piping system combinations with a swelling interaction (testing procedure III);
- which possible degradation situations of the functional layers may apply and the coverage of these situations by the testing programme and other evaluation moments;
- whether impact resistance testing according par. 3.5.3 is required.

I.4 Test method for the pipe construction

I.4.1 Testing procedure I

I.4.1.1 General
Provided that a number of chemical/piping system combinations are brought in by the applicant, the proposed chemical/piping system combinations will be divided into the following categories: chemical degradation and swelling. The second evaluation will first conclude about grouping of chemical liquid/polymer combinations within these categories. Secondly, the exact test conditions have to be determined that are to be applied for the main test. The tests according par. I.4.1.4 have to be carried out for the most aggressive chemical liquid per group. The other liquids within the groups have to be tested at $T_{\text{limit}}$ as explained in paragraph I.4.1.5.

I.4.1.2 Second evaluation moment

I.4.1.2.1 Grouping
Chemical/piping system combinations with the same lifetime and service conditions are grouped within a category. Only in the case of (a group of) chemical liquids having the same interaction on the plastics material and with the same declared lifetime and service conditions, the number of pressure tests can be limited, see par. I.4.1.5.

I.4.1.2.2 Determination of test conditions
On the basis of the main test according I.4.1.4, reliable test results have to be obtained from any chemical liquid/piping system combination tested. This means that combinations with an on beforehand predictable interaction, as well as combinations with interactions which are regarded as ‘less predictable” or “questionable” (these combinations are often called ‘specialties’) have to be able to be tested.

It therefore has to be evaluated which test conditions (temperature, pressure, time, see I.4.1.4) are appropriate and have to be applied.

It might be the case that pre-testing (see par. I.4.1.3) is required in order to be able to determine the test conditions for the main test. This can be the case for example when:
- the type of interaction is not known yet or cannot be predicted with certainty;
- ‘non-conforming’ interactions between the chemical and piping system under the defined test conditions can be expected, like:
  o when it is expected that the most aggressive situation does not occur at the highest operational temperature or at the highest concentration;

I.4.1.3 Pre-test
During the second evaluation moment (see I.4.1.2) it is decided whether a pre-test is required or not.

The details of the pre-test are depending on the evaluation of the chemical liquid/piping system combination under study together with the declared operational conditions, the possible test conditions and the purpose of the pre-test. For this reason it is not possible to further detail the pre-test.
On the basis of the outcome of the pre-test, the test conditions (concentration of the chemical liquid, test temperatures and pressures) to be applied during testing according I.4.1.4. are determined.

I.4.1.4 Main test

I.4.1.4.1 Introduction

Short term pressure tests on samples of the complete pipe construction are carried out at the highest possible test temperatures in order to determine the time to knee points for each particular chemical liquid/pipe construction combination at these high test temperatures. On the basis of the time to knee points, see figure I.1, the time to knee point at the intended service temperature can be calculated by using the ISO 9080 extrapolation method. The in this way calculated time to knee point as well as the pressure at the knee point at service temperature shall exceed the lifetime and pressure as stated by the certification applicant. In this way the intended application conditions and expected lifetime of the piping system can be approved and confirmed in the KiwaQuality certificate to be issued.

I.4.1.4.2 Internal pressure tests

Internal pressure tests are carried out on each pipe construction/chemical liquid combination as determined at evaluation moment 2. Testing takes place in accordance with table I.2. Testing starts with a total of 12 test pieces at 3 temperatures. The difference between the 3 temperatures shall be at least 10 °C. Data shall be generated at \( T_{\text{highest}} - 20 \) °C in case the activation energy is lower than compared to ISO 9080. If the activation energy is equal or higher than compared to ISO 9080, the extrapolation factors may be used for \( T_{\text{highest}} - 20 \) °C and testing at \( T_{\text{highest}} - 20 \) °C can be stopped.

Table I.2: Internal-pressure testing required for chemical liquids having an environmental stress cracking or oxidation interaction.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Resistance to internal pressure of the pipe construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing liquid</td>
<td>Chemical liquid concerned</td>
</tr>
<tr>
<td>Requirement</td>
<td>Determination of points of failure at the steep slope of the regression curve at different temperatures</td>
</tr>
<tr>
<td>Test parameters for the individual tests</td>
<td>Test temperature</td>
</tr>
<tr>
<td></td>
<td>( T_{\text{highest}} )</td>
</tr>
<tr>
<td></td>
<td>At time( t_2 )</td>
</tr>
<tr>
<td></td>
<td>( T_{\text{highest}} - 10 ) °C</td>
</tr>
<tr>
<td></td>
<td>At time( t_2 )</td>
</tr>
<tr>
<td></td>
<td>( T_{\text{highest}} - 20 ) °C</td>
</tr>
<tr>
<td></td>
<td>At time( t_2 )</td>
</tr>
</tbody>
</table>

Test method

ISO 1167 and ISO 9080

1) Highest possible test temperature (depending on the polymer(s) and pipe construction).
2) Pressure \( P_{\text{LPL}} \) corresponding to time\( t_1 \) and time\( t_2 \) failure of the ISO 9080 water regression line at test temperature; time\( t_1 \) and time\( t_2 \) and corresponding pressures should be chosen in such a way that times of failure at the steep slope of the regression curve are expected, see figure I.2.
3) Temperature step shall be at least 10 °C.
4) Data shall be generated at \( T_{\text{highest}} - 20 \) °C in case the activation energy is lower than compared to ISO 9080.

---

1) Highest possible test temperature according to the outcome of the applicable evaluation moment. This applies also to the other testing procedures whereby ‘the highest possible test temperature’ is mentioned.
I.4.1.4.3 Additional explanatory information

In order to be able to determine and confirm a minimum expected lifetime for a defined piping system for a certain chemical to be transported under defined application conditions, the following minimum test results shall be available:

- ISO 9080 long term hydrostatic strength test results for pipe construction and fitting material, showing the curves for the whole temperature range, including the SEM (standard extrapolation method) formula, and;
- Pressure test results for pipe construction and fitting material (see table I.2) on the basis of which the time to knee points of the particular chemical/piping system combination can be determined for a minimum of 2 temperatures with points of failure at the steep slope. Hereby, at least 4 times to failure per temperature are required. Pressure test results of the particular chemical/piping system combination can be used as well as test results with representative liquids (more critical chemical/application conditions combination(s) as explained in detail further in this document);
- Internal-pressure test results of the joints, see par I.5.

The above mentioned ISO 9080 test results are required because they provide for the estimation of the required pressures to be applied for chemical testing (see tables below) and for calculation of the knee points at different temperatures due to the degradation by the chemical (see figure I.2). The knee point is the intersection of the water regression line and the steep line through the pressure-time to failure data point with the chemical. With the calculated knee point, the time to and the pressure at the knee point at the declared temperature can be extrapolated using ISO 9080.

Approval and confirmation of the chemical/piping system combination for the intended service conditions and lifetime can be provided in case:

- The time to the knee point at the service temperature is equal or exceeds the lifetime as stated by the certification applicant;
- The pressure at the knee point at the service temperature is equal or exceeds the pressure as stated by the certification applicant.

Exceptions to the general testing scheme apply within the following cases (see also the flow chart of figure I.2):

- identical category of interaction (part of testing procedure I, see par. I.4.1.5)
- no interaction (see testing procedure II, par. I.4.2)

---

2 Per temperature 2 times to failure at the time \(_1\) stress level and at least 2 times to failure at the time \(_2\) stress level are required, see table I.1.
I.4.1.5 Identical group of interaction – reduced testing
For chemical liquids having the same interaction on the multilayer pipe and with the same declared lifetime and service conditions (which belong to the same group as explained in par. I.4.1.1), the number of pressure tests can be limited. For the most aggressive one, all temperatures from table I.2 have to be experimentally tested. For the others, only testing at the highest temperature has to take place. In case the most aggressive chemical cannot be confirmed (do not fulfil the requirements) for the intended lifetime and service conditions, the second most aggressive chemical have to be fully tested in accordance with table I.2. In case the declared lifetime and/or service conditions are different (more severe) for a less aggressive chemical liquid, then full testing according table I.2 is applicable.

I.4.1.6 Third evaluation moment
At this point it is evaluated whether the test results (after testing in accordance with par. I.4.1.4 and I.4.1.5) can be regarded as representative for the operational conditions. If not, then the testing procedure has to be repeated (but with other test conditions probably closer to the operational conditions) in order to be able to approve the chemical liquid for the declared PAR.

I.4.2 Testing procedure II
I.4.2.1 No interaction expected between chemicals and multilayer pipe
For pipe construction /chemical/service condition/lifetime combinations whereby no interaction between the chemical liquids and pipe construction are expected, applies that when no failure occurs after testing in accordance with table I.3, the chemical/pipe construction combination is expected to show no knee point and the lifetime can be confirmed according table I.3.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Resistance to internal pressure of the pipe construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing liquid</td>
<td>Chemical liquid concerned</td>
</tr>
<tr>
<td>Requirement</td>
<td>No failure</td>
</tr>
<tr>
<td>Test parameters for the individual tests</td>
<td>Test temperature</td>
</tr>
<tr>
<td></td>
<td>$T_{\text{highest}}$ 1)</td>
</tr>
<tr>
<td>Test method</td>
<td>ISO 1167 and ISO 9080</td>
</tr>
</tbody>
</table>

1) Highest possible test temperature (depending on the polymer)

Before the start of the test the applicable test conditions have to be determined and after the test it has to be assessed on the basis of the test results whether the chemical liquid can be regarded as having no interaction with the polymer. These assessments are regarded as a usual activity within the framework of testing and are therefore not regarded as special evaluation moments according par. I.2.

I.4.3 Testing procedure III
I.4.3.1 General
The swelling of semi-crystalline and amorphous plastics is often causing a reduction in stiffness and strength and thus of the pipe construction and fitting. A check on the stiffness and strength will be performed, in order to investigate whether the expected lifetime can be confirmed.
First a pre-test is carried out in order to investigate whether the performance of pressure tests with the chemical(s) concerned are not redundant and to check whether the maximum swelling degree(s) as defined at evaluation moment I are not exceeded.

**I.4.3.2 Pre-test and fourth evaluation moment**

The details of the pre-test are depending on the evaluation of the chemical liquid/piping system combination(s) under study together with the declared operational conditions and the possible test conditions. For this reason it is not possible to further detail the pre-test.

During the fourth evaluation moment the test conditions of the pre-test as well as the test conditions of the main test (see I.4.3.1.3) are determined.

**I.4.3.3 Main test**

In case the extrapolated strength level from the pre-test is exceeding the required one for the declared chemical liquid/polymer/service conditions combination and the degree of swelling is lower as defined during evaluation moment I, the acceptance criterions are fulfilled and pressure testing of the pipe construction with the chemical liquids(s) concerned in accordance with I.4.1.4 can start.

**I.5 Test method for the joints**

**I.5.1 General**

Part of the approval of the piping system is the testing of the chemical resistance of the joints. This is a so-called product test and applicable per production location combination of the pipes and fittings. This test has to be carried out for all chemical liquid/polymer combinations to which testing procedures I, II and III are applied.

Remark:

Parallel testing of the joints with water according to the applicable annex A till L and with the chemical liquid(s) according to this annex is advised in order to compare test results in case of failure.

**I.5.2 Fifth evaluation moment**

Before testing in accordance with I.5.3 takes place, it has to be assessed on the basis of information from literature, knowledge and competence whether the testing times in combination with the test temperature and hoop stress applied are appropriate for confirmation of the quality\(^1\) of the weld/joint.

\(^1\) Taking into consideration for example sufficient testing time in order to allow the chemical interactions (e.g. swelling and permeation affecting the weld/adhesive) having their effect.

**I.5.3 Testing of the joints after testing procedure I, II and III**

Hereby a pressure test with the chemical liquid(s) concerned is carried out, at the highest test temperature which is equal to the highest test temperature from the applied test procedure I, II and III for the pipe material, see table I.4.

In case test procedure I has been applied for the pipe and fitting material, the test has to be carried out on the most aggressive liquid as mentioned at ‘Identical group of interaction’ par. I.4.1.5.

No failure is allowed within the time to failure found for the pipe and/or fitting material.
Table I.4: Chemical resistance testing of the joints

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Resistance to internal pressure of the joints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing liquid</td>
<td>Chemical liquid concerned</td>
</tr>
<tr>
<td>Requirement</td>
<td>No failure of the joint before the calculated knee point of the pipe construction and/or fitting material determined in accordance with table I.2.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test parameters for the individual tests</th>
<th>Test temperature</th>
<th>Pressure</th>
<th>Number of test pieces</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$T_{\text{highest}}$</td>
<td>Equal to highest pressure at $T_{\text{highest}}$ from applied test procedure I, II or III for the pipe material</td>
<td>3$^2$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test method</th>
<th>ISO 1167</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test pieces</td>
<td>ISO 15975, part 5 series</td>
</tr>
</tbody>
</table>

1) Highest possible test temperature which is equal to the highest test temperature from the applied test procedure I, II, or III.

2) Preferably the smallest possible diameter from dimension group 1.

I.6 Approval of PAR

I.6.1 General
After testing with positive result, the expected lifetime, the chemicals to be transported and the application conditions (the PAR, see par. I.3) will be confirmed by issuing of the KiwaQuality (KQ) certificate. The application conditions are: minimum and maximum concentration of the chemical liquid, operational temperature, maximum temperature (for certain duration) and malfunctioning temperature (for a certain duration) of the chemicals to be transported and operational and maximum pressure applied in the piping system together with the minimum required wall thickness per diameter of the pipe or fitting. Depending on the application conditions, the expected lifetime can be different for each chemical to be transported.

I.6.2 Sixth evaluation moment
The following has to be checked and approved:
   a) the by the applicant stated lifetime of the piping system;
   b) the by the applicant stated operational pressure of the piping system for the intended dimensions;
   c) the temperatures $T_{\text{oper}}, T_{\text{max}}$ and $T_{\text{mal}}$ of the piping system.

   a) The lifetime is verified and approved according par. I.4.

   b) The operational pressure in combination with the intended dimensions of the pipes has to be verified for each diameter as follows.

   Situation 1: knee points detected
After chemical resistance testing, the maximum pressure at the knee point $P_{\text{knee}}$ at the operational temperature is known.

   Taking into account the design coefficient $C$ for the corresponding pipe material, each stated operational pressure versus diameter shall be checked according to the equation below, whereby the calculated pressure shall be lower than the pressure at the knee point $P_{\text{knee}}$ at the operational temperature.

   $$P_{\text{knee}} \geq P_{\text{operational}} \times C$$

   where $C$ the design coefficient for the corresponding pipe material.

   Situation 2: no interaction (no knee points detected)
The maximum pressure at the stated lifetime $P_{\text{life}}$ at the operational temperature is known.
via the ISO9080 curves with water.

Taking into account the design coefficient $C$ for the corresponding pipe material, each stated operational pressure versus diameter shall be checked according to the equation below, whereby the calculated pressure shall be lower than the pressure at the intended lifetime $P_{\text{lifetime}}$

$$P_{\text{lifetime}} \geq P_{\text{operational}} \times C$$

(The design coefficients $C$ have to be calculated, see paragraph 3.4.2 (which makes reference to clause 9.2 of ISO 21003-2).

c) The temperatures $T_{\text{oper}}, T_{\text{max}}$ and $T_{\text{mal}}$ shall be verified by means of extrapolation of the test results at $T_{\text{test}}$ according par. 1.4.
Annex II

Determination of the resistance to permeation

Principle and test method

II.1 Principle
Permeation measurements can be performed on the complete pipe as well as fitting or only on the plastics barrier layer material. This depends on the desired permeation information to be included in the certificates and has to be decided upon in consultation with the applicant.

For permeation measurements on the fitting material, paragraphs I.2 till I.4 are applicable.

For permeation measurements on the barrier layer of the pipe, paragraph I.4 is applicable.

For permeation measurements on more than one barrier layer or on the complete pipe, paragraph II.5 is applicable.

Permeation measurements are performed on the pipe as well as fitting material(s) by means of immersion tests. In case the fitting material is made from the same material as the pipe material, separate permeation tests are not required.

Permeation measurements with the chemical liquids to be transported (or components from these liquids) are always required for multilayer pipes. For the plastics fitting material they are – in principle – only significant under the following condition:

• when the corresponding liquids/components result in an absorption of at least 1 %.

An absorption of 1 % will result in a permeation rate of less than 1 g/m² (pipe surface)/day. This low permeation is expected for almost all aqueous salt solutions. Moreover, water molecules are the permeating components in aqueous salt solutions. High absorption will occur for swelling agents.

During the evaluation moment, see par. II.2, it has to be evaluated whether the permeation measurement is relevant for the chemical liquid/fitting polymer combinations concerned.

In case the outcome of the evaluation moment is that a check on the permeation is recommended, it has to be verified and confirmed via a pre-test, see par. II.3, that the absorption is above or below 1 %. Alternatively, the main test can be started (see par. II.4).

II.2 Evaluation moment
As explained in par. II.1, it has to be evaluated whether the pre-test for the chemical liquid/fitting polymer combination(s) concerned is required.

II.3 Pre-test fitting material
As mentioned in par. 2.11.2, permeation measurements with the chemical liquids to be transported (or components from these liquids) are required under the following condition:

• when the corresponding liquids/components result in an absorption of at least 1 %.

II.3.1 Test pieces
• cut 3 rings of a representative fitting, ∅ <100 mm and wall thickness < 3 mm, with a thickness in axial direction of 1 mm.

II.3.2 Method
• Dry the specimens for two days in an oven at 50 °C.
• Weigh the specimens.
• Immerse these specimens for 1 week in the declared liquid(s) at the highest declared operation temperature.
• Weigh the immersed specimens directly after this immersion and removal of droplets of the liquid.
• Check whether the weight increase is lower or higher than 1 % by mass.

II.3.3 Evaluation
In case test results show that the absorption is lower than 1 %:
• no further testing is recommended;
• In the applicable KQ certificate for the fitting will be mentioned that permeation of the chemical(s) has not to be taken into account during the stated lifetime of the piping system.

In case test results show that the absorption is higher than 1 % or the permeation rate is required by the applicant:
• testing according II.2 is required in order to obtain the permeation rate(s) (Q);
• the flow of substance Q through the fitting wall will be mentioned in the applicable KQ certificate for the fitting.

II.4 Main test (immersion test) on one pipe barrier layer or fitting material
II.4.1 Test pieces
• In general, a number of rings with < ∅ 100 mm and wall thickness < 3 mm and width of 20 mm can be taken as test pieces.
• Alternatively, samples of 100 x 100 x 3 mm can be taken as test pieces from a compression moulded plate with a thickness of 3 mm.

II.4.2 Method
• Dry the specimens for two days in an oven at 50 °C.
• Weigh the specimens.
• Immerse these specimens and weigh the specimens after 1, 4, 16, 25, 49, etc days³ until equilibrium is reached in the declared liquid(s) at the selected temperature and concentration(s)⁴; Weigh the immersed specimens directly after removal of droplets of the liquid.
• Determine the equilibrium absorption and by interpolation the time to realise an absorption level equal to half that of the equilibrium absorption (t₁/₂).

II.4.3 Calculation of D
The diffusion coefficient D (m² / s) is calculated as follows:

\[ D = \frac{\pi \times e^2}{64 \times t_{1/2}} \]

where:
D = the diffusion coefficient (m² / s);
e = the thickness of the test piece (m);
t₁/₂ = the half absorption time (s).

³ An alternative time table can be used depending on the rate of absorption.
⁴ The highest declared operational temperature and concentrations will be quantified. On request, measurements at other temperatures and concentrations can be included.
II.4.4 Calculation of Q
The flow of substance Q per m pipe/fitting length is calculated as follows:

\[ Q = \frac{D \times C}{e_x} \times \pi \times d_a \times 86400 \]

where:
Q = the flow of substance (kg/m/24h);
D = the diffusion coefficient (m²/s);
e_x = the pipe/fitting wall thickness (m);
C = the concentration of the model liquid in the pipe/fitting material, calculated according the underneath mentioned formula, (kg/m³);

\[ C_i = \frac{M_s - M_o}{\rho_m \times \rho_L} \]

\[ d_n = \text{the nominal pipe/fitting diameter (m)} \]

where:
M_s = the saturated mass of the test piece (kg);
M_o = the mass of the test piece before immersing (kg);
ρ_m = the specific mass of the pipe/fitting material (kg/m³);
ρ_L = the specific mass of the model liquid (kg/m³);

II.5 Main test (immersion or bottle test) on more than one pipe barrier layers or complete pipe

The flow, Q_{m1,c1}, of component c₁ through a layer m₁ through a layer is given by:

\[ Q_{m1,c1} = \frac{D_{m1,c1} \times c_{m1,c1} \times A_{m1}}{e_{m1}} \times \Delta a_{m1,c1} \times \Delta \]

where \(D_{m1,c1}\) is the diffusion coefficient of component c₁ in layer m₁, A_{m1} the effective surface of layer m₁ through which the permeation occurs, \(e_{m1}\) the thickness of layer m₁, \(c_{m1,c1}\) the equilibrium sorption of component c₁ in material m₁ after immersion and \(\Delta a_{m1,c1}\) the difference in activity of component c₁ over the wall thickness of layer m₁.

The equations for D, Q and c per layer are given in sections II.4.3.
A set of indices is required to calculate the permeation for a multilayer pipe (m₁ – mₙ) and a multi component mixture (c₁-c_p).

When a pipe consists of n layers and 1 component is considered, the following equations hold:

\[ Q_{m1,c1} = Q_{m2,c1} = \ldots = Q_{mn,c1} \]

\[ \Delta a_{m1,c1} + \Delta a_{m2,c1} + \ldots + \Delta a_{mn,c1} = 1 \]

When the variation in circumference is neglected over the total wall of the pipe and \(D_{m1,c1} \times c_{m1,c1}\) is replaced by \(P_{m1,c1}\), the following equation holds:
\[ Q_{m1,c1} \times \frac{e_{m1}}{P_{m1,c1}} + Q_{m2,c1} \times \frac{e_{m2}}{P_{m2,c1}} + \ldots + Q_{mn,c1} \times \frac{e_{mn}}{P_{mn,c1}} = 1 \]

A barrier layer \((mB)\) is characterized by a low \(P_{mB,c1}\) value, a high \(e_{mB}\) value and \(\Delta a_{mB,c1} = 1\).

The permeation of all individual components of the liquid can be calculated using the equation given above. It is proposed to quantify the liquid mixture as one effective component when possible.

The permeation through the whole multilayer pipe can be quantified as well. However, it is noted that the period before permeation starts and the actual measurement starts can become long. The lap time is given by:

\[
\frac{1}{6} \left( \frac{e_{m1}^2}{D_{m1,c1}} + \frac{e_{m2}^2}{D_{m2,c1}} + \ldots + \frac{e_{mn}^2}{D_{mn,c1}} \right) = 1
\]

Moreover, the bottle test instead of the immersion test has to be performed when the permeation of the whole multilayer pipe is quantified.

In case the bottle test method is used, the principles of the bottle test according BRL 17101, par. 5.8 shall be applied. Hereby, the test specimen are filled with the chemical liquid(s) under study. The details of the test are to be elaborated during a separate evaluation moment.
Technical approval-with-product certificate

<Name of the plastics piping system>

Based on pre-certification tests as well as periodic inspections by Kiwa, the products referred to in this certificate and marked with the KiwaQuality-mark as indicated under ‘marking’, manufactured by

XYZ Company

may, on delivery, be relied upon to comply with the KiwaQuality evaluation guideline BRL-K17603 "Plastics piping systems for the transport of chemical liquids for industrial applications”.

Kiwa N.V.

Ing. B. Meekma
Director

This certificate is issued in accordance with the Kiwa-regulations for Product Certification and consists of … pages. Publication of the certificate is allowed.

Company

XYZ Company
Semi-crystalline Road 1
1234 AA PLASTICS
The Netherlands
Telephone +31-12-345 6789
Telefax +31-12-345 6790
Internet www.xyzcompany.nl
Technical approval-with-product certificate

< Name of the plastics piping system >

PRODUCT SPECIFICATION

General
Plastics piping systems of ..., intended for the underground and above ground transport of chemical liquids for industrial applications according to BRL-K17603.

Specification
The plastics piping systems consists of:
- ........ pipes: colour ......., according to the KiwaQuality certificate K ......
- ........ fittings, colour ......., according to the KiwaQuality certificate K ......

The nominal outside diameters and accompanying wall thicknesses of the pipes as mentioned in the table below belong to this technical approval-with-product certificate.

<table>
<thead>
<tr>
<th>Nominal outside diameter of the pipe</th>
<th>SDR .......</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>Y</td>
<td>2</td>
</tr>
<tr>
<td>Z</td>
<td>3</td>
</tr>
</tbody>
</table>

Remarks
The colour of the pipes is: ....... inside/ ....... outside.
The colour of the fittings is: .......

APPLICATION AND USE

The products are designed for the transport of the chemical liquids and application conditions as mentioned in the table below.
In this table the product approval range (PAR) is given for each chemical liquid to be transported.

<table>
<thead>
<tr>
<th>Chemical liquids</th>
<th>Concentration profile (%)</th>
<th>Temperature profile (°C)</th>
<th>Pressure profile (bar)</th>
<th>Minimum expected lifetime (years)</th>
<th>Permeation rate (^{1}) (kg/m/24h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid 1</td>
<td>1 – 2</td>
<td>1 – 2</td>
<td>1 – 2</td>
<td>1</td>
<td>X</td>
</tr>
<tr>
<td>Liquid 2</td>
<td>2 – 3</td>
<td>2 – 3</td>
<td>3 – 4</td>
<td>2</td>
<td>Y</td>
</tr>
<tr>
<td>Liquid 3</td>
<td>3 – 4</td>
<td>3 – 4</td>
<td>5 – 6</td>
<td>3</td>
<td>Z</td>
</tr>
</tbody>
</table>

\(^{1}\)The permeation rates are applicable for the complete system (pipes and fittings). It is up to the user to check whether these permeation rates are acceptable or not.

Permeation of the chemical liquid(s) through the plastics pipe and fitting wall are not foreseen within the declared lifetime(s) of the piping system.

With regard to above ground applications, the plastics piping systems are not intended to be exposed to direct sunlight and weathering during the minimum expected lifetime(s) as indicated in the table above.

The technical approval-with-product certificate is only applicable if the requirements mentioned in paragraph 2.16 of the Evaluation Guideline are fulfilled. These are:

Installation and user instructions
The manufacturer shall provide proper written installation and user’s instructions in the language of the country where the piping systems are to be installed and used. These instructions shall also reference compliance with the national environmental regulations pertaining to the storage and transport of chemicals. National regulations e.g. can stipulate requirements for preventing accidental impact to the piping system and requirements with regard to leak detection. National regulations may also stipulate that the installation is to be carried out by certified installers.

The certification body shall approve these instructions.
Technical approval-with-product certificate

< Name of the plastics piping system >

MARKING

The products are marked with the KiwaQuality-mark (KQ-mark).

Pipes:
The minimum required marking of the pipes is:
• KQ Industry (or KiwaQuality©Industry word mark);
• Manufacturer’s name and/or trade name and/or system name and/or logo;
• certificate number of this technical approval-with-product certificate;
• BRL-K17603;
• Material identification;
• Nominal outside diameter and nominal wall thickness of the pipe in mm;
• Date of production (may be provided in code).
The realization of the marks is as follows: durable and indelible at intervals of not more than 2 m.

Fittings:
The minimum required marking on the fittings is:
• KQ Industry (or KiwaQuality©Industry word mark), if not possible, then only on the smallest packaging;
• Manufacturer’s name and/or trade name and/or system name and/or logo;
• Nominal outside diameter of the corresponding pipe in mm;
• Date of production (may be provided in code).

The smallest packaging unit of the fittings shall be provided with at least the following information:
• KQ Industry (or KiwaQuality©Industry word mark);
• Manufacturer’s name and/or trade name and/or system name and/or logo;
• certificate number of this technical approval-with-product certificate;
• BRL-K17603;
• Material identification;
• Nominal outside diameter of the corresponding pipe in mm;
• Date of production (may be provided in code).

The realization of the marks is as follows: durable and indelible on each fitting/packaging.

RECOMMENDATIONS FOR USERS

1. Check at the time of delivery whether:
   1.1 the producer has delivered in accordance with the agreement;
   1.2 the mark and the marking method are correct;
   1.3 the products show no visible defects as a result of e.g. transport.

2. If you should reject a product on the basis of the above, please contact:
   2.1 Company name
   and, if necessary,
   2.2 Kiwa N.V.

3. Consult the producer’s processing guidelines for the proper storage and transport methods.

4. Check whether this certificate is still valid by consulting the Kiwa internet site: www.kiwa.nl.
Annex IV ‘Pipe product certificate’

Number K12345/01  Replaces
Issued 2009-01-01  Date

Product Certificate

Plastics pipes for the transport of chemical liquids

Based on pre-certification tests as well as periodic inspections by Kiwa, the products referred to in this certificate and marked with the KiwaQuality-mark as indicated under ‘marking’, manufactured by

XYZ Company

may, on delivery, be relied upon to comply with the KiwaQuality evaluation guideline BRL-K17603 “Plastics piping systems for the transport of chemical liquids for industrial applications”.

Kiwa N.V.

Ing. B. Meekma
Director

This certificate is issued in accordance with the Kiwa-regulations for Product Certification and consists of … pages. Publication of the certificate is not allowed.

Company

XYZ Company
Semi-crystalline Road 1
1234 AA PLASTICS
The Netherlands
Telephone +31-12-345 6789
Telefax +31-12-345 6790
Internet www.xyzcompany.nl
Product Certificate

Plastics pipes for the transport of chemical liquids

PRODUCT SPECIFICATION

General
Plastics pipes made of ..., intended for the underground and above ground transport of chemical liquids for industrial applications according to BRL-K17603.

Specification
The nominal outside diameters and accompanying wall thicknesses of the pipes as mentioned in the table below belong to this product certificate.

<table>
<thead>
<tr>
<th>Nominal outside diameter of the pipe</th>
<th>SDR</th>
<th>Minimum wall thickness of the pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Remarks
The colour of the pipes is: inside/outside.

APPLICATION AND USE

The pipes are designed to be used in piping systems for the transport of the chemical liquids and application conditions as mentioned in the table below. In this table the product approval range (PAR) is given for each chemical liquid to be transported.

<table>
<thead>
<tr>
<th>Chemical liquids</th>
<th>Concentration profile (%)</th>
<th>Temperature profile (°C)</th>
<th>Pressure profile (bar)</th>
<th>Minimum expected lifetime (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid 1</td>
<td>1 – 2</td>
<td>1 – 2</td>
<td>1 – 2</td>
<td>1</td>
</tr>
<tr>
<td>Liquid 2</td>
<td>2 – 3</td>
<td>2 – 3</td>
<td>3 – 4</td>
<td>2</td>
</tr>
<tr>
<td>Liquid 3</td>
<td>3 – 4</td>
<td>3 – 4</td>
<td>5 – 6</td>
<td>3</td>
</tr>
</tbody>
</table>

With regard to above ground applications, the plastics pipes are not intended to be exposed to direct sunlight and weathering during the minimum expected lifetime(s) as indicated in the table above.

The permeation rate(s) of the piping system are specified in the accompanying technical approval-with-product certificate for each chemical liquid to be transported.

MARKING

The pipes are marked with the KiwaQuality-mark (KQ-mark).

The minimum required marking of the pipes is:
- KQ Industry (or KiwaQuality©Industry word mark);
- Manufacturer’s name and/or trade name and/or system name and/or logo;
- Certificate number of this technical approval-with-product certificate;
- BRL-K17603;
- Material identification;
- Nominal outside diameter and nominal wall thickness of the pipe in mm;
- Date of production (may be provided in code).

The realization of the marks is as follows: durable and indelible at intervals of not more than 2 m.
Product Certificate

Plastics pipes for the transport of chemical liquids

RECOMMENDATIONS FOR USERS

1. Check at the time of delivery whether:
   1.1 the producer has delivered in accordance with the agreement;
   1.2 the mark and the marking method are correct;
   1.3 the products show no visible defects as a result of e.g. transport.

2. If you should reject a product on the basis of the above, please contact:
   2.1 Company name
   and, if necessary,
   2.2 Kiwa N.V.

3. Consult the producer’s processing guidelines for the proper storage and transport methods.

4. Check whether this certificate is still valid by consulting the Kiwa internet site: www.kiwa.nl.
Product Certificate

Plastics fittings for the transport of chemical liquids

Based on pre-certification tests as well as periodic inspections by Kiwa, the products referred to in this certificate and marked with the KiwaQuality-mark as indicated under ‘marking’, manufactured by

XYZ Company

may, on delivery, be relied upon to comply with the KiwaQuality evaluation guideline BRL-K17603 "Plastics piping systems for the transport of chemical liquids for industrial applications".

Kiwa N.V.

Ing. B. Meekma
Director

This certificate is issued in accordance with the Kiwa-regulations for Product Certification and consists of … pages. Publication of the certificate is not allowed.

Company

XYZ Company
Semi-crystalline Road 1
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The Netherlands
Telephone +31-12-345 6789
Telefax +31-12-345 6790
Internet www.xyzcompany.nl
Product Certificate

Plastics fittings for the transport of chemical liquids

PRODUCT SPECIFICATION

General
Plastics fittings made of ..., intended for the underground and above ground transport of chemical liquids for industrial applications according to BRL-K17603.

Specification
The nominal diameters of the fittings as mentioned in the table below belong to this product certificate.

<table>
<thead>
<tr>
<th>Nominal diameter</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
</tr>
</thead>
</table>

Remarks
The colour of the fittings is: ......

APPLICATION AND USE

The fittings are designed to be used in piping systems for the transport of the chemical liquids and application conditions as mentioned in the table below. In this table the product approval range (PAR) is given for each chemical liquid to be transported.

<table>
<thead>
<tr>
<th>Chemical liquids</th>
<th>Concentration range (%)</th>
<th>Temperature range (°C)</th>
<th>Pressure range (bar)</th>
<th>Minimum expected lifetime (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid 1</td>
<td>1 – 2</td>
<td>1 - 2</td>
<td>1 - 2</td>
<td>1</td>
</tr>
<tr>
<td>Liquid 2</td>
<td>2 – 3</td>
<td>2 - 3</td>
<td>3 - 4</td>
<td>2</td>
</tr>
<tr>
<td>Liquid 3</td>
<td>3 - 4</td>
<td>3 - 4</td>
<td>5 - 6</td>
<td>3</td>
</tr>
</tbody>
</table>

With regard to above ground applications, the plastics fittings are/are not intended to be exposed to direct sunlight and weathering during the minimum expected lifetime(s) as indicated in the table above.

The permeation rate(s) of the piping system are specified in the accompanying technical approval-with-product certificate for each chemical liquid to be transported.

MARKING

The fittings are marked with the KiwaQuality-mark (KQ-mark).

The minimum required marking of the fittings is:
- KQ Industry (or KiwaQuality©Industry word mark), if not possible, then only on the smallest packaging;
- Manufacturer’s name and/or trade name and/or system name and/or logo;
- Nominal outside diameter of the corresponding pipe in mm;
- Date of production (may be provided in code).

The smallest packaging unit of the fittings shall be provided with at least the following information:
- KQ Industry (or KiwaQuality©Industry word mark);
- Manufacturer’s name and/or trade name and/or system name and/or logo;
- Certificate number of this technical approval-with-product certificate;
- BRL-K17603;
- Material identification;
- Nominal outside diameter of the corresponding pipe in mm;
- Date of production (may be provided in code).

The realization of the marks is as follows: durable and indelible on each fitting/packaging.
Product Certificate

Plastics fittings for the transport of chemical liquids

RECOMMENDATIONS FOR USERS

1. Check at the time of delivery whether:
   1.1 the producer has delivered in accordance with the agreement;
   1.2 the mark and the marking method are correct;
   1.3 the products show no visible defects as a result of e.g. transport.

2. If you should reject a product on the basis of the above, please contact:
   2.1 Company name
       and, if necessary,
   2.2 Kiwa N.V.

3. Consult the producer’s processing guidelines for the proper storage and transport methods.

4. Check whether this certificate is still valid by consulting the Kiwa internet site: www.kiwa.nl.
### Model IQC scheme

<table>
<thead>
<tr>
<th>Inspection subjects</th>
<th>Inspection aspects</th>
<th>Inspection method</th>
<th>Inspection frequency</th>
<th>Inspection registration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw materials or supplied materials, half products:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- recipe sheets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>incoming goods inspection raw materials</td>
<td></td>
<td></td>
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<tr>
<td>- plastics</td>
<td></td>
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</tr>
<tr>
<td>- rubber</td>
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<tr>
<td>- metals</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Production process, production equipment, plant:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- procedures</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- working instructions</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>- equipment</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>- plant</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>End products</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measuring and testing equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- measuring means</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>- calibration</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Logistics</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>- Internal transport</td>
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<td></td>
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</tr>
<tr>
<td>- Storage</td>
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<td></td>
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</tr>
<tr>
<td>- Preservation</td>
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</tr>
<tr>
<td>- Packaging</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Identification or marking of semi-manufactures and end-products</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Annex VII
Identification of products

VII.1 Introduction
The chemical liquids to be transported and the accompanying application conditions to be
taken into account are directly related to the piping system (to be) installed. A correct and also
easy identification of the products is therefore required.

The identification of the products takes place via:
- the applicable KiwaQuality certificates, in combination with;
- the marking of the products.

VII.2 Identification of products
Applicable KiwaQuality certificates and marking of the products
Separate certificates are issued for the fittings, pipes and piping system. Only the front page of
the certificate will be publicly available via the website of Kiwa. The complete certificate,
including information about the chemical liquids to be transported and their product approval
ranges, have to be obtained via the certificate holder(s) or can be issued by Kiwa only after
approval of the certificate holder.

As mentioned in par. 1.3 and I.4.4, part I of the list of approved polymers/compounds for
fitting plastics materials is publicly available. This part of the list gives information about
chemical liquids to be transported with specified approved application conditions, related to
different types of polymers. This information will not be repeated in the certificates to be
issued. In the certificates and in addition to part I of the list, only the operational pressure(s)
and, if applicable, permeation rates will be mentioned.

Part II of the list of approved polymers/compounds is not publicly available. Information
about chemicals to be transported, the product approval range etc is included in the
certificate(s).

It is the responsibility of the certificate holder(s) to inform their customers, installers, end-users
etc, about the contents of the KiwaQuality certificate(s). The version number and date of issue
can be verified via the frontpage of the certificate(s) which are published on the Kiwa website.

From the marking of the pipes and fittings, see par. 2.14, it can be checked whether the correct
products are delivered, as well as to which piping system(s) the pipes and fittings belong.
Subsequently, the possible chemical liquids to be transported and the appropriate application
conditions are specified in part I of the list of approved polymers/compounds and in the
corresponding technical approval-with-product certificate (system certificate) as explained
above.