

Draft BRL K17201, part 1

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# Evaluation Guideline

For the Kiwa Process Certificate for  
Renovation of drinking water pipes - Part 1 –  
Design and Installation of Cured-in-Place Pipe (CIPP) –  
Factory Impregnated Liner Systems



Trust  
Quality  
Progress

## Preface

This Evaluation Guideline (BRL) has been accepted by the Kiwa Board of Experts Water Cycle (CWK), in which all relevant parties in the field of “Renovation of drinking water piping systems – Design and Installation of cured in place pipes (CIPP) – factory-impregnated liner systems” are represented. This Board of Experts also supervises the certification activities and where necessary requires the BRL to be revised. All references to Board of Experts in this BRL pertain to the above mentioned Board of Experts.

This BRL will be used by Kiwa in conjunction with the Kiwa Regulations for Certification.

This BRL, together with BRL-K17201 part 2 – “Renovation of drinking water piping systems – Products for cured in place pipes (CIPP) – factory-impregnated liner systems” is a series of BRL’s that among other things include requirements for the design, installation, semi-finished products, and end products of cured in place pipes.

**NOTE: THIS IS AN ENGLISH TRANSLATION OF THE DUTCH VERSION OF THIS EVALUATION GUIDELINE. IN CASE OF A DISPUTE, THE DUTCH VERSION SHALL BE BINDING.**

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The use of this assessment directive by third parties, for any purpose whatsoever, is only allowed after a written agreement is made with Kiwa to this end.

### **Validation**

This evaluation guideline has been declared binding by Kiwa on **Date**

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## 1 Introduction

### 1.1 General

This Evaluation Guideline (BRL) includes all relevant requirements which are employed by Kiwa when dealing with applications for the issue and maintenance of a Kiwa process certificate for “Renovation of drinking water pipes – Design and installation of cured-in-place-pipe (CIPP)” – Factory Impregnated Liner System.

This BRL replaces BRL K17201 part 1 dated 8<sup>th</sup> February 2017. The quality declarations issued based on that version of the BRL lose their validity after 6 months of validation of this BRL.

For the performance of its certification work, Kiwa is bound to the requirements as included in EN-ISO/IEC 17065 “Conformity assessment - Requirements for bodies certifying products, processes and services”.

### 1.2 Scope

The scope of this BRL is a technique used for the renovation of underground and above-ground water pipes under pressure and with a round cross-section by means of pipes that harden on-site (CIPP technique).

The renovated piping systems are intended for the transport of drinking water with a maximum temperature of 35 °C.

The scope of certification is the installation process of a liner system consisting of various components as described in § 4.3. This includes the fittings (couplings) and the connections.

The liners are factory impregnated.

Repairs and partial renovations of drinking water pipes fall outside the scope of this BRL. Repairs to the liner itself do fall within the scope of this BRL.

### 1.3 Acceptance of test reports provided by the supplier

If the supplier provides reports from test institutions or laboratories to prove that the products meet the requirements of this BRL, the supplier shall prove that these reports have been drawn up by an institution that complies with the applicable accreditation standards, namely:

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

#### **Remark:**

This requirement is considered to be fulfilled when a certificate of accreditation can be shown, issued either by the Dutch Accreditation Council (RvA) or by one of the institutions with which an agreement of mutual acceptance has been concluded by the RvA.

The accreditation shall refer to the examinations as required in this BRL.

When no certificate of accreditation can be shown, Kiwa shall verify whether the requirements of the accreditation standard are fulfilled.

### 1.4 Quality declaration

The quality declaration to be issued by Kiwa is described as a Kiwa process certificate.

A model of the certificate to be issued based on this BRL has been included for information in Annex I.

## 2 Terms and definitions

### 2.1 Definitions

In this BRL, the following definitions, abbreviations and symbols apply:

- **Board of Experts:** the Board of Experts Water Cycle (CWK).
- **Inspection (audit) tests:** tests carried out after the certificate has been granted in order to ascertain whether the certified products and/or processes continue to meet the requirements recorded in the BRL.
- **Certification mark:** a protected trademark of which the authorization of the use is granted by Kiwa, to the supplier whose products and/or processes can be considered to comply on delivery with the applicable requirements.
- **Drinking water:** water intended or partly intended for drinking, cooking or food preparation or other domestic purposes, but does not include hot water.
- **Evaluation Guideline (BRL):** the agreements made within the Board of Experts on the subject of certification.
- **Factory-impregnated liner:** The resin is mixed with the necessary curing agents and optionally other additives at the production location. Production tools and equipment are only intended to be used for the renovation on drinking water piping systems.
- **Initial investigation:** tests in order to ascertain that all the requirements recorded in the BRL are met.
- **IQC scheme (IQC):** a description of the quality inspections carried out by the supplier as part of his internal quality system.
- **Process Certificate:** a document in which Kiwa declares that a process meets and shall continue to meet the requirements on which the process specification is based.
- **Product Design Specification (PDS):** a declaration stating the intended usage of a product that has not yet been designed.
- **Supplier:** the party that is responsible for ensuring that the products and/or processes meet and continue to meet the requirements on which the certification is based.
- **Technical specification:** a description of the product after it has been designed.

In addition, the terms, and definitions according to EN-ISO 11298-1 and EN-ISO 11298-4 apply.

### 2.2 Abbreviations

In this BRL the following abbreviations are used.

Abbreviation	Denotes
CKB	Foundation for the Certification Scheme for Cable Infrastructure and Pipe Laying Companies
CIPP	Cured-in-place pipe
BoE-CWK	Board of Experts Water Cycle (CWK)
IQC	Internal quality control
PDS	Product Design Specification
PVE	Programme requirements
RVO	Report of completion
VCA	Safety Checklist Contractors

## 2.3 Symbols

The symbols used in this BRL denote the following.

<b>Symbol</b>	<b>Denotes</b>
$d_{em}$	Mean outside diameter
$d_{em, min}$	Minimum mean outside diameter
$d_n$	Nominal outside diameter
$e$	Wall thickness
$e_m$	Mean wall thickness
$e_{min}$	Minimum wall thickness at any point
$e_n$	Nominal wall thickness
$E_S$	Modulus of elasticity on the basis of the initial ring stiffness in accordance with ISO 7685
$E_F$	Modulus of elasticity on the basis of the three point flexural test in accordance with EN-ISO 178
$E_0$	Short-term flexural modulus
$\sigma_{fb}$	Flexural stress at first break
$\varepsilon_{fb}$	Flexural strain at first break
$h_c$	Wall thickness of the structural (construction) layer
$S$	Specific ring stiffness

### **3 Procedure for granting a Kiwa certificate**

#### **3.1 Initial investigation**

The initial investigation to be performed based on the (process) requirements as detailed in this BRL, including the test methods, and comprises of the following:

- a (sample) investigation to determine whether the processes used meet the process and/or performance requirements;
- the assessment of the process;
- the assessment of the quality system and the IQC scheme;
- an assessment of the presence and functioning of the other applicable procedures.

#### **3.2 Granting the Kiwa certificate**

After finishing the initial investigation, the results are presented to the Decision Maker (see § 9.2) for evaluation. The Decision Maker evaluates the results and decides whether the certificate can be granted or if additional data and/or tests are necessary.

#### **3.3 Investigation of the process and/or performance requirements**

Kiwa will investigate the processes to be certified (or have them investigated) on the basis of the certification requirements in this BRL.

If necessary, the required samples will be taken by or on behalf of Kiwa.

#### **3.4 Process assessment**

When assessing the process, it is checked whether the manufacturer is able to continuously carry out the process that meets the certification requirements.

The assessment of the process takes place during the ongoing work at the manufacturer.

#### **3.5 Contract assessment**

If the supplier is not the party performing the process to be certified, Kiwa will assess the agreement between the supplier and the party that performs the process.

This written agreement, which is available to Kiwa, includes at least that accreditation bodies, product managers and Kiwa shall be granted access to observe the certification activities being carried out on these processes.

## **4 Process requirements and test methods**

### **4.1 General**

This chapter contains the process requirements with which the work carried out for the renovation of water pipes using the CIPP technique shall comply with. These requirements will be part of the technical specification of the process that will be included in the process certificate to be issued.

During the initial evaluation, Kiwa checks whether the installation process has been described and implemented and whether it meets the process requirements.

The process certificate is only valid if the applied liner system is certified according to BRL K17201, part 2, Products.

For each CIPP liner system, the structure of the product along with the individual components such as resin system, carrier, sealing material, etc. shall be specified in terms of:

- Product and type designations;
- name of the manufacturer of the (intermediate) component(s);
- properties (materials, dimensions, mechanical, physical);

in accordance with BRL K17201, part 2, § 4.4.3 “Declaration of the liner system”. This aspect is covered by the certification of the liner in accordance with BRL K17201, part 2.

### **4.2 Regulatory requirements**

#### **4.2.1 Requirements to avoid deterioration of the quality of drinking water**

Products and materials which (may) come into contact with drinking water or warm tap water, shall not release substances in quantities which can be harmful to the health of the consumer, or negatively affect the quality of the drinking water. Therefore, the products or materials shall meet the toxicological, microbiological, and organoleptic requirements as laid down in the latest "Ministerial Regulation materials and chemicals drinking water and warm tap water supply", (published in the Government Gazette). Consequently, the procedure for obtaining a quality declaration, as specified in the current Regulation, shall be concluded with positive results in accordance with the requirements of BRL K17201, Part 2.

Products and materials with a quality declaration, e.g., issued by a foreign certification institute, are allowed to be used in the Netherlands, provided that the Dutch Minister has declared this quality declaration to be equivalent to the quality declaration as meant in the Regulation.

### **4.3 Process requirements**

#### **4.3.1 CIPP-technique**

The process consists of a pipe-in-pipe relining technique for the renovation of above ground and underground water pipes. A flexible impregnated liner is installed through a shaft, an inspection opening, an access opening or an outflow opening. A new pipe is formed by curing the liner in the pipe to be renovated (CIPP technique).

The following installation options are available:

- The inversion of the impregnated liner by means of overpressure (compressed air or steam);
- The inversion of the impregnated liner by means of water pressure;
- Pulling in the liner into the drinking water pipe to be renovated.

The installation process shall take place in such a way that damage to the liner is prevented. The pressure shall be kept as constant as possible during the entire inversion process.

#### **4.3.2 Curing of the resin system**

Curing of the resin system takes place by means of, for example, circulation of hot water, blowing in steam or ultraviolet light and shall be in accordance with the instructions of the manufacturer of the resin and / or the installer.

During curing the temperature curve of the liner shall be recorded. In addition, the pressure on the liner shall be constantly monitored. These measurements shall be in accordance with established work instructions.

After installation of the CIPP liner, any connections (if applicable) are opened and subsequently sealed using the technique certified in accordance with BRL K17201, Part 2.

#### 4.4 Construction of the liner pipe system

The installation consists of the components as detailed in Table 1.

**Table 1 – Components of the liner pipe system**

Item	Description
1	Liner (see BRL K17201, Part 2)
2	Components required for the watertight and durable sealing of the connections <sup>1)</sup> (see BRL K17201, Part 2)

1) Various techniques for obtaining watertight and durable seals are permitted, provided that it has been demonstrated that they meet the relevant requirements and type tests in accordance with BRL K17201, Part 2.

The materials and components used for each installed liner shall be recorded by the installer. No components other than those certified in accordance with BRL K17201, part 2 may be used.

#### 4.5 Process structure

This BRL contains the requirements and test methods of the various stages from the “Design”, “Installation”, “commissioning” and “Delivery”. These process steps are listed in Figure 1.

BRL-K17201-1 Renovation of drinking water pipes – Design and Installation of Cured-in-Place Pipe (CIPP) – Factory Impregnated Liner Systems

Input	Process step	Output	Process-owner
Requirements of the customer and the competent authority	GENERAL DESIGN	Product Design Specification	Certified in accordance with BRL K17201, Part 1
Product Design Specification & detailed information	DETAILED DESIGN	Technical specification / Preliminary action plan	Certified in accordance with BRL K17201, Part 1
Preliminary action plan	DECOMMISSIONING/ INSPECTION/CLEANING/ /INSPECTION	Definitive action plan	Certified in accordance with BRL K17201, Part 1
Definitive action plan	INSTALLATION	Installation & Checklist Installation	Certified in accordance with BRL K17201, Part 1
Testing and sampling procedure	PERFORMANCE TESTING & (SAMPLES)	Test report & (samples)	Certified in accordance with BRL K17201, Part 1
Installation	COMMISSIONING	Operational installation	Certified in accordance with BRL K17201, Part 1
Functional testing of the installation	HANDOVER TO THE CLIENT	Commissioning report & Log book & certificate	Certified in accordance with BRL K17201, Part 1

Figure 1 – Process steps for the renovation of water pipes

#### 4.5.1 General design

The general requirements of the customer shall be included in the Product Design Specification (PDS) of the liner system. The PDS determines the requirements for the intended usage of the product that has not yet been designed.

The PDS shall be approved and accepted by the customer or the customer's representative. If a permit is required, the PDS shall also be approved and accepted by the competent authority.

After acceptance of the PDS by the customer and, if applicable, the competent authority, the following process steps shall be applicable. The certificate holder validates the PDS of the liner system to be used.

#### 4.5.2 Detailed design

##### 4.5.2.1 General

The organization shall ensure, in a controlled manner, that at least the following aspects/procedures regarding the detailed design (§ 4.5.2.2 up to and including § 4.5.2.5) have been covered.

Based on the detailed design accepted by the customer, the installer draws up a preliminary action plan.

#### 4.5.2.2 Design determination

Before starting the design work, the installer shall determine the following:

- The design and development steps;
- The appropriate method of assessment, verification and validation for each design and development step;
- The installer shall identify the interfaces between different groups involved in the design process to ensure effective communication and clear allocation of responsibilities;
- The planning output shall be updated as appropriate as the design progresses.

#### 4.5.2.3 Design assessment

Periodic design reviews shall be carried out to:

- Assess whether the design and development results can meet the requirements;
- Identify any problems and propose necessary actions.

Furthermore, the following shall apply:

- Records of the assessment results and any necessary measures taken are kept;
- Verifications are carried out to determine that the final design has met the input requirements and are recorded.

#### 4.5.2.4 Design calculation

A standardized calculation method shall be used for the realization of the final design such as:

- Statistical calculation in accordance with ASTM F1216 “Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube”,

or:

- A calculation model/method established by the client

The design calculation is carried out on the basis of, design parameters such as the (composite) thickness, the elasticity modulus of the liner and the other declared properties in accordance with of BRL K17201, part 2.

The designer shall consider at least the following basic information:

- Basic information to be supplied by the client about the condition of the pipe to be renovated, including all (environmental) parameters that may influence the design, and including the expected out-of-roundness of the pipe to be renovated. In case the expected out-of-roundness is greater than 2%, it may be necessary to adjust the design, and this shall be checked by calculation;
- Where applicable, information derived from previous, similar designs;
- Other requirements essential for the design and development;
- The input shall be assessed for suitability. The requirements shall be complete, unambiguous, and non-contradictory.

In case the liner cannot be fully mechanically loaded, it calculation shall prove that the expected gap at the location of the transition between the connection (appendage/fitting) and the liner can be bridged.

#### 4.5.2.5 Result (final design) and release

The parameters for the final design shall be specified prior to its' release. Records of the results of the validation and any necessary measures shall be retained.

The decision maker responsible for the release the final design shall have the following qualification:

- Experience with at least 10 projects as a designer.

The final design template shall be in a form suitable for verification against the design and development input. This template shall be approved prior to it being used.

The result of the design shall:

- Meet the input requirements for the design;
- Provide appropriate information for all interested (external) parties;
- Contain or refer to the acceptance criteria for the product;
- Specify the basic features essential for proper installation.

### 4.5.3 Decommissioning, technical specification and preliminary & definitive action plan

The certified installer validates the detailed design by means of a technical specification and the provisional and definitive action plan. The technical specification describes the actual product as designed. The action plan contains information to ensure the correct installation of the liner.

The definitive action plan can only be established after the water pipe to be renovated has been decommissioned and the pipe has been cleaned and inspected with a camera. The correct status of the pipeline to be renovated shall be determined so that it is clear what the action plan shall consider. Important points for attention are:

- Whether the actual out-of-roundness concurs with the design out-of-roundness;
- Whether any obstacles need to be removed or repairs made. Irregularities in the pipeline to be renovated may occur but may not touch the reinforced (stress-bearing) layer(s) of the liner.

The action plan shall contain at least the following elements:

- Total decommissioning period of the water mains and the communications with the residents, and other parties concerned;
- Risk analysis regarding the necessity of installing facilities to minimize / prevent the entry of groundwater and / or dirt during installation of the liner;
- Drinking water hygiene code;
- Any requirements and conditions imposed by the client, legislator, or the permit;
- Registration and procedure of the course of curing.

### 4.5.4 Installation

#### 4.5.4.1 General

The procedures, registrations and requirements shall be specified in the installer's IQC scheme.

#### 4.5.4.2 Personnel

The installation of the liner shall be carried out by skilled and authorized personnel (see § 7.8). For installation purposes, use can be made of the checklist according to Annex III.

#### 4.5.4.3 Equipment

The installer shall use the equipment specified by the liner system manufacturer (if specified).

The installer shall have a procedure (manual) to demonstrate that relevant registrations will take place, e.g.:

- Procedure and method of registration of the laminate temperature, curing time and, if applicable, the applied pressure on the liner during the curing time when using water or steam.

#### 4.5.4.4 Validatie van de installatie

The installer validates the installation of the liner according to a written procedure.

### 4.5.5 Sampling and testing

The sampling and testing shall be carried out by authorized personnel and can be initiated by different parties (see Table 2).

**Table 2 – Samples taken on behalf of various parties**

Testing type	On behalf of:	Sampling shall be performed by or in the presence of authorized personnel
Initial investigation	Kiwa	Kiwa
Inspection	Kiwa	Kiwa
	Installer	Installer
	Client	Client

The personnel responsible for taking the test pieces shall identify the test pieces with a unique identification and registration.

The identification of the test piece includes at least:

- Name and signature of the authorized person taking the test pieces;
- Unique identification number.

A model information sheet for sampling and testing is included in Annex IV.

It is permitted to take a test piece outside the pipeline to be renovated, provided that the liner outside the pipeline to be renovated is supported in an equivalent manner. In addition, it shall be possible to check the wall construction, as well as to determine the other properties in accordance with § 5.7.

The dimensions of the sample shall be such that all test pieces for the tests (§ 5.7) can be prepared from the sample. The sample shall also meet the requirements necessary for proper performance of the tests.

The tests shall be carried out by a laboratory accredited on the basis of EN-ISO 17025 or by a laboratory that has been verified and approved by Kiwa.

The installer shall demonstrate that the installed liner complies with this BRL. Test pieces shall be taken from each installed liner for carrying out the necessary tests (§ 5.7).

A deviation with regard to any test result will be registered and recorded by the installer in accordance with the requirements of EN-ISO 9001.

A disagreement between the installer and the customer regarding any test result will be resolved within four weeks. Kiwa will be informed about this by the installer. If Kiwa is approached directly by the customer about this disagreement, Kiwa will inform the installer about this.

In addition to sampling and testing to be carried out by the installer, test pieces are taken by Kiwa, and tests are carried out with a frequency as indicated in chapter 8.

#### **4.5.6 Commissioning**

After installation and pending the test results of the samples, the installation can be provisionally released and commissioned. This provisional release and commissioning shall take place under the responsibility of the certified installer and by qualified personnel and consists of all the activities in order to ensure that the installation is functionally and operationally in accordance with the action plan.

The installation shall be checked for proper functioning before commissioning.

The installer shall have a written procedure for carrying out the commissioning.

Results of assessments and contingencies required to commission the liner system shall be recorded.

The following can be used for commissioning:

- Camera inspection of the installed liner;
- Assessment of the connections;
- Checking the functioning of the liner system.

Commissioning shall be validated by a person authorized by the certified installer.

#### **4.5.7 Handover to the client**

The installer shall have a written procedure regarding the transfer of the installation to the client.

The installer shall submit a report of completion (RVO) that includes at least:

- A declaration in which the installer states that the installed liner functions in accordance with the technical specification and the validated design as indicated in § 4.5.1 and § 4.5.2;
- Technical specifications;
- Action Plan;
- Summary of the results of all checks and tests carried out;

- Recording and video data of the camera inspection, if required in the technical specification;
- Detailed description of all certified components of the liner system and the tools used;
- Reference to the certificate of the products used;
- (Automatic) recording of mixing, if applicable;
- (Automatic) registration of equipment calibration, if applicable;
- (Automatic) registration of the curing e.g., temperature registration, speed of the lamps etc., if applicable.

The report shall also demonstrate that all components and tools meet the requirements of BRL K17201, parts 1 and 2.

#### **4.6 Installation-instructions and user instructions**

The installer shall provide appropriate installation and user instructions in the language of the country where the liner system is installed. These instructions shall refer to compliance with any applicable national laws and regulations.

## **5 Product requirements and test methods**

### **5.1 General**

This chapter contains the product requirements and test methods pertaining to the installed liner system.

A distinction is made between “manufactured” phase (M phase) and “installed” phase (I phase). The “M-phase” refers to the phase as produced in the factory prior to any on-site processing of the components required for the CIPP technique.

The “I-stage” refers to the components of the CIPP liner that have been installed on-site after they have been cured.

The national evaluation guideline BRL K17201, part 2 “Products” specifies the various properties of the components and materials in both phases.

The requirements for the components and materials in the M phase shall form part of the installer's IQC scheme. The chapter "Raw materials and/or supplied materials" of the IQC scheme shall specify the properties and test methods that are applicable.

All product requirements included in this national BRL refer to the I phase.

### **5.2 Liner system**

The installer shall demonstrate the suitability of the liner and the components used.

The components of the installed liner system shall be Kiwa certified in accordance with BRL K17201, part 2.

To adequately demonstrate their suitability and origin, at least the following points apply:

- Description of the material composition of all components;
- Description of the (design) wall structure;
- Detailed drawings of the liner system;
- Detailed drawings of the connections / seals and work instructions for making the connections / seals;
- Description of the production of the finished product along with the components used, including a description of the installation procedure used.

### **5.3 Requirements for the installed product**

The finished product as installed shall be in accordance with the requirements of the PVE / specification of the client.

### **5.4 Sealing technology used**

The sealing technique used shall conform to the certified product according to BRL K17201, part 2.

### **5.5 Leak tightness of the liner**

Before the connections are opened, the leak tightness of the installed liner shall be examined in accordance with:

- VEWIN guideline chapter 11 on hydrostatic pressure testing for drinking water pipes outside buildings;
- Possibly supplemented with instructions and requirements from the designer of the piping system.

The testing shall be carried out in accordance with the work instructions which shall be available on site. These instructions shall be in the Dutch-language. The result of the test shall be recorded.

### **5.6 Liner wrinkles**

Any wrinkles in the liner that occur during the installation shall comply with the following:

- On straight lengths and bends with a radius greater than 10x the diameter of the liner the wrinkle shall not be more than 2% of the nominal diameter, with a maximum of 6 mm.

- For bends with a radius between 5x to 10x the diameter of the liner and with a round profile the highest and lowest point of the wrinkle shall be maximum of 3% of the nominal diameter of the liner with a maximum of 2 cm.
- For the special case of bends with a radius smaller than 5x the diameter of the liner, the limits of wrinkle formation shall be agreed separately in the specifications.

Note: Verification of these requirements by camera inspection is allowed.

Wrinkle formation in the reinforced layer (reinforcement) is not allowed.

## 5.7 Testing of samples

### 5.7.1 General

In accordance with § 4.5.5, the installer shall demonstrate that the installed liner complies with this BRL. Unless indicated otherwise, test pieces shall be taken once per project for conducting the tests in accordance with this paragraph.

The required test pieces are obtained from, for example:

- Part of the liner that can be removed, for example, at the location of a coupling to be fitted;
- By producing an extra length of liner by using a support pipe just outside the water pipe to be relined, such that the wall thickness of the liner in the support pipe does not change. This can be subsequently determined after sawing through the liner.

With glass fibre reinforced liners there is a good chance that the mechanical properties in the axial and circumferential direction of the liner (tube) differ. This will be apparent from the initial assessment. If it turns out that the properties are anisotropic, then the mechanical properties shall be declared for the different directions.

### 5.7.2 Average wall thickness

The average wall thickness is determined for each liner installed.

The wall thickness is measured at least at 6 regularly distributed locations on the edge of the test piece. The average of the values measured is the average wall thickness. The average wall thickness  $e_m$  shall be at least equal to or greater than the design thickness.

If the average wall thickness  $e_m$  is lower than the design thickness, then a recalculation shall be made to demonstrate that the installed liner still meets the requirements.

### 5.7.3 Elasticiteitsmodulus

The short term modulus of elasticity shall be determined on the basis of a three point flexural test in accordance with EN-ISO 178 and EN-ISO 11298-4 Annex B or on the basis of the initial ring stiffness in accordance with ISO 7685.

Remark In practice it has been established that the modulus of elasticity calculated on the basis of ISO 7685 (ring stiffness) can be a maximum of 10% higher than the modulus of elasticity calculated on the basis of a three-point bending test. The differences in the width of the test pieces is an important cause for these differences.

This difference may be corrected on the condition that the correlation factor  $\gamma$  has been determined for the relevant CIPP type. The correlation factor  $\gamma$  shall be calculated as follows:

$$\gamma = \frac{E_s}{E_F}$$

Where  $E_F$  is the (average) modulus of elasticity based on a three point flexural test in accordance with ISO 11298-4 Annex B. The (average) modulus of elasticity based on the ring stiffness  $E_s$  shall be calculated as follows:

$$E_s = 12 \times \left( \frac{d_m}{h_c} \right)^3 \times S$$

The correlation factor  $\gamma$  is set at 1 if it has not been otherwise determined experimentally for the relevant type of CIPP.

The average short term modulus of elasticity of the installed liner ( $E_{0,brt,mean}$ ) shall be at least 90 % of the corresponding declared value ( $E_{0,tt,5\%}$ ).

#### 5.7.4 Tensile strength

The tensile strength of the liner or liner parts shall be determined in accordance with ISO 8513 (axial direction) and ISO 8521 (circumferential direction). 5 dumbbells shall be tested from both directions.

The average tensile strength determined for each direction shall be at least equal to the declared value for the tensile strength. The tensile strength to be determined and declared shall be determined according to the same test method.

As an alternative, other test methods are also possible, such as determination of the glass content. The correlation between the methods shall be demonstrated by the certificate holder and shall be validated by Kiwa.

#### 5.7.5 Three point flexural test

The following properties shall be determined by means of a three-point flexural test in accordance with EN-ISO 178:

- Short duration flexural modulus ( $E_0$ );
- Bending stress at first break ( $\sigma_{fb}$ );
- Bending strain at first break ( $\epsilon_{fb}$ ).

The values measured shall be at least equal to the declared values

#### 5.7.6 Barcol hardness

The degree of curing of the resin used shall be determined by means of hardness measurements on test plates which have been exposed in the pipe liner to the same time and temperature profile as that of the liner pipe. This shall be demonstrated by the installer. The hardness measurements shall be carried out with a Barcol 934-1 hardness meter on a non-porous part of the cured resin surface of the above test plates at a temperature of 10 – 30 °C in accordance with EN 59. The hardness requirements listed in Table 3 shall be met.

**Table 3 – Testing for the curing of the resin**

Type resin system	Requirement	Test parameter	Test method
Epoxy	Not less than the declared value	Barcol 934-1	EN 59
Polyester/ Vinyl ester	Not less than the declared value	Barcol 934-1	EN 59 ISO 4901
Styrene-free resin systems	Not less than the declared value	Barcol 934-1	EN 59

## 6 Marking

### 6.1 Certification mark

After certification, the certification mark shall also be included in the report of completion (RVO) (see § 4.5.7).

The certified installer can include the Kiwa certification mark (see below) in combination with the certificate number e.g., in quotations, brochures, website, etc.



Kiwa certification mark

## **7 Requirements for the quality system**

This chapter contains the requirements which shall be met by the supplier's quality system.

### **7.1 Manager of the quality system**

The supplier shall appoint a Quality Systems Manager who shall report directly to the director.

### **7.2 Internal quality control/quality scheme**

The supplier shall have an internal quality control scheme (IQC scheme) which has been implemented within the organisation. The following shall be demonstrably recorded in this IQC scheme:

- the aspects that are checked by the supplier;
- the methods used to perform such inspections ;
- the frequency of these inspections ;
- the manner of recording and archiving the inspection results .

This IQC scheme shall be in the format of the model IQC scheme as included in Annex II.

### **7.3 Control of test and measuring equipment**

The supplier shall verify the availability of the required test and measuring equipment for demonstrating product conformity with the requirements of this BRL.

When required the equipment shall be calibrated periodically. The calibration status of each equipment shall be traceable by means of a unique identification number.

The supplier shall keep records of the calibration results.

If the equipment is out of calibration then the supplier shall review the validity of the data previously recorded by that equipment.

### **7.4 Procedures and working instructions**

The supplier shall be able to submit the following:

- procedures for:
  - dealing with products showing deviations;
  - corrective actions to be taken if non-conformities are found;
  - dealing with complaints about products and/or services delivered;
- the working instructions and inspection forms used.

### **7.5 Registration with the Chamber of Commerce**

The installer shall be registered with the Chamber of Commerce.

### **7.6 Third Party Insurance**

The installer shall be insured against legal liability.

### **7.7 Formation of the relining team**

The installer shall record the names and functions of the persons of the relining team and, if applicable, any change of persons.

The quality manager of the relining team shall be present during the execution of the relining work.

### **7.8 Personnel qualifications**

The installer is responsible for qualifying personnel who will perform the relining. It shall be demonstrated that the personnel are competent enough to carry out the relining process under the certificate requirements.

A written procedure shall be available in which this qualification procedure is included. This includes at least:

- The professional competence and knowledge level required from the employees who carry out the relining;
- Knowledge of safety and hygienic working on drinking water pipes and specifically with the working methods (courses, instructions);

- a. All personnel who work on the installation liners or on liners that have already been installed (supervisors, fitters, mechanics, cable and pipe installers) shall demonstrably have followed a CKB-recognized course “Hygienic work on drinking water pipelines”.
  - b. For personnel at work, the training and courses followed shall be demonstrably recorded in a personal "passport" (also referred to as a "safety passport").
- The training of employees who carry out the relining;
  - Supervision by qualified employees of the employees in training who carry out the relining;
  - The (re-)qualification methods;
  - Required skills;
  - Responsibilities in nominating for qualification, qualifying, authorizing and registering;
  - Registration;
  - Archiving.

### **Registration**

The installer has an up-to-date qualification register, which includes at least the following:

- Personal data, possibly personnel number;
- Date of last qualification, method of qualification;
- Content of the qualification;
- End date of the qualification;
- Re-qualifications;
- Persons in training, end date of training, mentor, registration number.

### **Third Party Control**

After mutual consultation it shall be agreed as to when Kiwa can verify the practical implementation of the qualification procedure on a random basis.

## **7.9 VCA-certificate**

The installer shall have a VCA\*\* certificate.

## **7.10 Requirements for the subcontractor**

If the entire relining process is outsourced to subcontractors, these subcontractors shall also be certified on the basis of this BRL.

If parts of the relining process are outsourced, the IQC scheme shall contain comprehensive procedures by which the certified installer ensures that the quality delivered by the subcontractor is guaranteed. This shall cover the following aspects:

- Equipment / material to be deployed;
- Work instructions for the subcontractor;
- Checks to be carried out by the subcontractor;
- Follow-up inspection by the certified installer;
- Quality registration of the subcontractor and the certified installer;
- The knowledge and skills required by the subcontractor for the work to be performed.

The certified installer shall supervise the quality of the work carried out by third parties and declare his IKB scheme applicable here as well.

The certified installer is ultimately responsible for the complete relining process including all the outsourced parts.

## **7.11 Document Management**

The installer shall implement a system for managing at least the following documents:

- a) IQC scheme, quality plans, work instructions, procedures, checklists, organizational chart, registration forms;
- b) Qualifications and qualification records;
- c) Standards and guidelines, including relevant safety data sheets;
- d) Documents associated with a specific process step, including the PVE, action plan, sampling report, laboratory reports, installation statement, RVO;
- e) Logbook containing all relining projects that have been and are being carried out, which fall under this certificate.

The certified installer shall have the following documents available in his office:

- All documents referred to under “a) to d)”;
- EN-ISO 9001 if certified;
- VCA\*\* certificate;
- Chamber of Commerce registration;
- Proof of a valid third-party insurance;

The installation team of the certified installer shall have the following documents available:

- Procedures, work instructions;
- Checklists, registration forms;
- Relevant action plan;
- Validated copy of the Kiwa certificate.

#### **7.12 Material Storage**

Material shall be stored in accordance with the supplier's storage instructions.

#### **7.13 Registration / checklist**

Registrations and checklists shall be maintained as specified in the IQC scheme of the installer.

#### **7.14 Declaration of installation**

After completion of the relining work, the installer shall complete a report of completion (RVO) within the agreed time and forward it to the customer. A copy shall be kept with the installer for at least five years.

#### **7.15 Certification mark**

After completion of the relining process, the installer shall affix the certification mark (see § 6.1) and include a reference to BRL K17201 part 1.

## 8 Summary of tests and inspections

This chapter contains a summary of the tests and inspections to be performed for the certification of the process:

- **Pre-certification:** the investigation necessary to determine whether all the requirements of the BRL are fulfilled;
- **Inspection visit:** the surveillance inspections carried out after issue of the certificate to ensure that the certified products continuously fulfil the requirements of this BRL. The inspections are carried out by Kiwa according to the indicated frequency;
- **Inspection of the quality system of the supplier:** inspection with regard to the correct implementation of the IQC-scheme and procedures.

### 8.1 Investigation matrix

The requirements that shall be fulfilled in order to qualify for certification are listed in Table 4. After certification Kiwa shall periodically inspect the manufacturer for his continued compliance with this BRL.

**Table 4 – Investigation matrix**

Description	BRL	Pre-certification		Inspection visit	
		Office	Project	Office	Project
Process	Chapter 4	x	x	x	x
Product	Chapter 5	x	x	x	x
Marking	Chapter 6	x	x	x	x
Quality system	Chapter 7	x	x	x	x
Installer	Chapter 8	x	x	x	x

The frequency of these inspections shall be as stated in Table 5.

**Table 5 – Inspection frequency**

Kiwa visits	Office inspection	Project inspection
Pre-certification	Once (1x)	Once (1x)
Control / inspection	1x per year	2x per year per relining team

Remark: Relining of more than one liner systems can be assessed during the same visit.

### 8.2 Control of the quality system

The supplier's quality system shall be assessed by Kiwa. This assessment includes at least the aspects stated in the Kiwa Regulations for Certification.

## 9 Agreements on the implementation of certification

### 9.1 General

The certification body shall have regulations, or an equivalent document, in which the general rules used for certification are specified.

In particular these are:

- the general rules for conducting the pre-certification tests, in particular:
  - the way suppliers are to be informed about how an application is being handled;
  - how the investigation is conducted;
  - the decision to be taken as a result of the pre-certification tests.
- the general rules for conducting inspections and the aspects to be audited,
- the measures to be taken by the certification body in case of Non-Conformities,
- the measures taken by the certification body in case of improper use of Certificates, Certification Marks, Pictograms and Logos,
- terms for termination of the certificate,
- the possibility to lodge an appeal against decisions or measures taken by the certification body.

### 9.2 Certification personnel

The staff involved in the certification have the following responsibilities:

- Certification assessor (**CAS**): responsible for carrying out the pre-certification tests and assessing the site assessors' reports;
- Site assessor (**SAS**): responsible for carrying out external inspections at the supplier's works;
- Decision maker (**DM**): responsible for deciding whether the supplier can be certified on the basis of the pre-certification tests carried out and for the continuation of the certification based on the external inspections carried out and for taking decisions on the need for corrective actions.

#### 9.2.1 Qualification requirements

The qualification requirements for all personnel of a certification body performing certification activities shall consist of:

- the requirements in accordance with EN ISO / IEC 17065, and
- any extra qualification requirements set by the Board of Experts for the subject matter of this BRL.

Education and experience of the certification personnel as detailed in Table 6 shall be recorded in a traceable manner.

**Table 6 – Qualification requirements for certification personnel**

Basic requirements	Evaluation criteria
Knowledge of company processes Requirements for conducting professional audits on products, processes, services, installations, design, and management systems.	<i>Relevant experience: in the field</i> <b>SAS, CAS</b> : 1 year <b>DM</b> : 5 years inclusive 1 year with respect to certification Relevant technical knowledge and experience on the level of: <b>SAS</b> : High school <b>CAS, DM</b> : Bachelor

Basic requirements	Evaluation criteria
Competence for execution of site assessments. Adequate communication skills (e.g., reports, presentation skills and interviewing technique).	<b>SAS:</b> Kiwa Audit training or similar and 4 site assessments including 1 autonomic under review.
Execution of initial examination	<b>CAS:</b> 2 initial applications under review.
Execution of review	<b>CAS:</b> evaluation of 3 reviews

Technical competences	Evaluation Criteria
Education	<b>General:</b> Education in one of the following technical areas: • Engineering.
Relevant testing knowledge	<b>General:</b> • Training (general and scheme specific) including measuring techniques.
Experience - specific	<b>CAS</b> • 2 complete applications self-reliant (to be evaluated by <b>PM</b> ) <b>SAS</b> • 2 inspection visits together with a qualified <b>SAS</b> )
Skills in performing witnessing	<b>SAS</b> Internal training witness testing

Legenda:

- Certification assessor (**CAS**)
- Decision maker (**DM**)
- Product manager: (**PM**)
- Site assessor (**SAS**)

### 9.2.2 Qualification

The qualification of the Certification staff shall be demonstrated by means of assessing the education and experience in accordance with the above requirements. In case the certification staff is qualified on the basis of alternative criteria, written records shall be kept.

The authority to qualify staff rests with the:

- **PM:** qualification of **CAS** and **SAS**;
- management of the certification body: qualification of **DM**.

### 9.3 Report initial investigation

The certification body records the results of the initial investigation in a report. This report shall comply with the following requirements:

- completeness: the report provides conclusions on all requirements included in the BRL;
- traceability: the findings on which the conclusions have been based shall be recorded and traceable;
- basis for decision: the **DM** shall be able to base his decision on the findings included in the report.

### 9.4 Decision for granting the certificate

The decision for granting the certificate shall be made by a qualified Decision maker who has not been involved in the pre-certification tests. The decision shall be recorded in a traceable manner.

### 9.5 Layout of quality declaration

The process certificate shall be in accordance with the model included in Annex I.

## **9.6 Nature and frequency of third party audits**

The certification body shall carry out surveillance audits to ensure that the supplier complies with his obligations. The Board of Experts decides on the inspection frequency to be observed.

When this BRL came into effect, the frequency was determined in accordance with Table 5.

Checks will in any case relate to:

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

The findings of each inspection shall be recorded by Kiwa in a traceable manner in a report.

## **9.7 Non conformities**

When the certification requirements are not met, measures are taken by Kiwa in accordance with the sanctions policy as written in the Kiwa Regulation for Certification.

## **9.8 Report to the Board of Experts**

The certification body shall report annually to the Board of Experts regarding the certification activities performed. In this report the following aspects are included:

- mutations in number of issued certificates (granted/withdrawn);
- number of audits executed in relation to the required minimum;
- results of the inspections;
- measures taken for established non-conformities;
- complaints received about certified products.

## **9.9 Interpretation of requirements**

The Board of Experts may record the interpretation of requirements of this BRL in a separate interpretation document.

## 10 Titles of standards

### 10.1 Public legislation

Dutch Government Gazette (“Staatscourant”) dated 1 July 2017	Regulation on materials and chemicals drinking water and warm tap water supply (“Regeling Materialen en Chemicaliën drink- en warm tapwatervoorziening”)
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### 10.2 Normen / normatieve documenten

Nummer	Titel	Versie
ASTM F1216-21	Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube	2021
BRL-K17201, part 2	Renovation of drinking water piping systems – Products for cured in place pipes (CIPP) – factory impregnated liner systems	2023
ISO 8513	Plastics piping systems – Glass-reinforced thermosetting plastics (GRP) pipes – Test methods for the determination of the initial longitudinal tensile strength	2016
ISO 8521	Glass-reinforced thermosetting plastic (GRP) pipes – Test methods for the determination of the initial circumferential tensile wall strength	2020
EN 59	Glass reinforced plastics – Determination of indentation hardness by means of a Barcol hardness tester	2016
EN 805	Water supply – Requirements for systems and components outside buildings	2000
EN-ISO 178	Plastics – Determination of flexural properties	2019
EN-ISO 527-4	Plastics – Determination of tensile properties – Part : Test conditions for isotropic and orthotropic fibre-reinforced plastic composites	2021
EN-ISO 9001	Quality management systems – Requirements	2015
EN-ISO 11298-1	Plastics piping systems for renovation of underground water supply networks – Part 1: General	2018
EN-ISO 11298-4	Plastics piping systems for renovation of underground water supply networks – Part 4: Lining with cured-in-place pipes	2021
EN-ISO/IEC 17020	Conformity assessment – Requirements for the operation of various types of bodies performing inspection	2012
EN-ISO/IEC 17021-1	Conformity assessment – Requirements for bodies providing audit and certification of management systems – Part 1: Requirements	2015
EN-ISO/IEC 17024	Conformity assessment – General requirements for bodies operating certification of persons	2012
EN-ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories	2018
EN-ISO/IEC 17065	Conformity assessment – Requirements for bodies certifying products, processes and services	2012
ISO 4901	Reinforced plastics based on unsaturated-polyester resins – Determination of the residual styrene monomer content, as well as the content of other volatile aromatic hydrocarbons, by gas chromatography	2011
ISO 7685	Plastics piping systems - Glass-reinforced thermosetting plastics (GRP) pipes – Determination of initial specific ring stiffness	2019
VEWIN Directive Drinking water pipes outside buildings – Design, installation and maintenance (based on EN 805)		

**Annex I. Model certificate (example)**



**Process certificate  
KXXXXXXX/XX**

Issued *yyyy-mm-dd*

Replaces

Page *1 of 1*

CERTIFICATE

**Name process**

**STATEMENT BY KIWA**

With this process certificate, issued in accordance with the Kiwa Regulations for Certification, Kiwa declares that legitimate confidence exists that the processes carried out by

**Name supplier**

as specified in this process certificate and marked with the Kiwa<sup>®</sup>-mark in the manner as indicated in this process certificate may, on delivery, be relied upon to comply with Kiwa evaluation guideline BRL-Kxxxx "xxxxxxxxxxxxxxxxxxxxxxxx" dated [dd-mm-yyyy] inclusive amendment sheet dated dd.mm.yyyy.

Ron Scheepers  
Kiwa

*Publication of this certificate is allowed.  
Advice: consult [www.kiwa.nl](http://www.kiwa.nl) in order to ensure that this certificate is still valid.*

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Company  
Name supplier  
Address supplier  
  
Phone number  
www.  
Email

Certification process consists of Initial and regular assessment of:

- quality system
- process

**Annex II. Model IQC scheme (informative)**

<p><b><u>IQC-schedule</u></b> <b><u>INTERNAL QUALITY PLAN</u></b></p>	<p>Manufacturer / supplier : Production location address :</p>	<p>Number of appendices:</p>
<p><u>Field(s) of application</u> On-site curing piping systems for the renovation of drinking water pipes According to BRL(s) BRL 17201, part 1 “Design and installation”</p>		
<p><u>Number of (installation) crews:</u></p>	<p><u>Quality manual, procedures and working instructions</u> Is the Quality Management System (QMS) certified according to ISO 9001<sup>1)</sup>? If yes, by which certification body: If yes, is the certification body accredited for the particular scope of certification?</p> <p>The following procedure for dealing with <u>complaints</u> applies: In case the QMS is <b>not</b> certified according to EN-ISO 9001:</p> <ul style="list-style-type: none"> <li>• Working instructions, test instructions and procedures are documented as follows:</li> <li>• The following procedure for <u>nonconformity review</u> applies:</li> </ul>	
<p><u>Quality Control</u> Total number of employees in QC department : Number of quality personnel per crew :</p>		
<p><u>Inspection and test records</u> All records shall be maintained for a minimum of        years.</p>		
<p><u>Specific agreements/comments/explanations</u></p>	<p>Signature of the manufacturer/supplier: Date :</p>	

<sup>1)</sup> In case the QMS is EN-ISO 9001 certified and covers the scope of the process certificate(s), reference to the applicable procedure(s) is sufficient in the tables A to F. In that case, only the frequency of tests/inspections (to be approved by Certification Body) is to be completed in tables B, C and D.

<b>A. Calibration of measuring and test equipment</b> Applicable procedure(s) nr(s):				
Equipment to be calibrated	Calibration aspect	Calibration method	Calibration frequency	Calibration file (name and location)
<b>B. Inspection of raw materials, additives and product (liner)</b> Applicable procedure nr(s):				
<b>B.1 Transport</b> The method of transport of the fully or partially prefabricated liner is recorded as follows:				
<b>B.2 Receipt</b> For each delivery of raw material or additives data with respect to dates, producers, types and quantities are recorded as follows:				
<b>B.3 Receiving inspection</b>				
Type of raw material	Inspection aspect	Inspection method	Inspection frequency	Registration file (name and location)
Resin	Type			
	Charge / batch number			
	Packaging			
	Marking			
Liner	Type			
	Charge / batch number			
	Appearance			
	Construction			
Appendages				
Other				

<b>B.4 Storage</b>				
Resin				
Liner				
Other				

<b>C. Liner release testing per installed liner (including check during installation and final check of finished product)</b> Applicable procedure no(s): Production process(es):				
Type product	Type test	Test method	Test frequency	Registration file (name and location)
Installed liner	Wall construction			
	Wall thickness			
	Short term ring stiffness			
	E-modulus			
	Liquid density			
	Flow profile			
	Curing			

Specific agreements/comments/explanations:

<b>D. Process verification tests</b> Applicable procedure(s) nr(s):				
Type of product	Type of test	Test method	Test frequency	Registration file (name and location)
Installeerde liner	Wall construction			
	Wall thickness			
	Short term ring stiffness			
	E-modulus			
	Liquid density			

	Doorstroomprofiel			
	Curing			

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

Specific agreements/comments/explanations:

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

### **Annex III. Installation checklist attention points (normative)**

The procedures (work instructions) for the installation shall contain at least the following items.

- Instruction: outside temperature at which relining is no longer permitted.
- Instruction: outside temperature at which relining is not recommended, but at which relining is still possible if special measures are taken.
- Work instructions for precautions to be taken at low outside temperatures.
- Work instruction: cleaning existing pipe.
- Work instruction: camera inspection.
- Check whether the type and dimensions of the liner match the data on the installation drawing.
- Work instructions regarding any preparation(s) required before the liner can be placed (e.g., application of a support pipe or PVC coupling pipe).
- Work instructions for impregnating the liner.
- Work instructions for inserting the liner (method and means).
- Work instructions for the finishing work necessary after curing of the liner.
- Work instructions for connecting the liner to connecting pipes (laterals).

Remark

Before starting the renovation work, ensure that the pipeline to be renovated has been put out of operation.

Further check that the liner and resin materials comply with:

- Specified liner system.
- Batch number.
- Use-by date (of resin/other components).
- Temperature range of the liner and other components.
- Marking in accordance with the hazardous substances' regulations.
- Visual damage

**Annex IV. Sampling and testing data sheet (normative)**

**Initial test**

**Repeat test**

With test report no.

**Sampling data**

Controlled by (name)	Sampling		Confirmation of sampling (installation company/site manager)	
	Date	Time	Capitals	Signature

**Test identification**

Client material test		Material-ID				
Main contractor		Description pipe				
Construction project		Description sample				
Installation company		Installation date				
Manufacturer (liner)		Condition of old pipe	<input type="radio"/> I	<input type="radio"/> II	<input type="radio"/> III	
Material	Resin	Support	Place of collection	Pipe <input type="radio"/>	End pit <input type="radio"/>	Intermediate pit <input type="radio"/>
				Top <input type="radio"/>	Between <input type="radio"/>	Bottom <input type="radio"/>
Pipe geometry	<input type="radio"/> Round <input type="radio"/> Oval		Position of collection			
Membrane is an integrated part of the liner	<input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Outside <input type="radio"/> Inside					

**Short-term properties required by the client**

**Test results (Please tick the tests to be carried out!) Note: 1 MPa = 1 N/mm<sup>2</sup>**

**Bending E-modulus, bending stress** according to EN-ISO 178 (three-point bending test)

<input type="checkbox"/>	Test date	E <sub>0</sub> [MPa]	σ <sub>FB</sub> [MPa]	h <sub>c</sub> [mm]	<input type="checkbox"/>
			Test direction	<input type="radio"/> Axial <input type="radio"/> Radial	

**Tensile strength** according to ISO 527, part 4

<input type="checkbox"/>	Test date	Longitudinal direction (N)	45° (N)	90° (N)	<input type="checkbox"/>

**Leak tightness** according to VEWIN Directive Drinking water pipes outside buildings (chapter 11 hydrostatic pressure test)

<input type="checkbox"/>	Test date	Test time [min]	Test pressure [bar]	Test result
				<input type="radio"/> Leak tight <input type="radio"/> Leakage

**Barcol hardness EN 59**

<input type="checkbox"/>	Test date	Location	Value

**Beoordeling van de resultaten**

Requirement	Acceptable	Not Acceptable	Requirement	Acceptable	Not Acceptable
Bending E-modulus	<input type="radio"/>	<input type="radio"/>	Tensile strength	<input type="radio"/>	<input type="radio"/>
Bending stress	<input type="radio"/>	<input type="radio"/>	Barcol hardness	<input type="radio"/>	<input type="radio"/>
Wall thickness	<input type="radio"/>	<input type="radio"/>	24h-Creep tendency	<input type="radio"/>	<input type="radio"/>
Leak tightness	<input type="radio"/>	<input type="radio"/>	Wrinkles	<input type="radio"/>	<input type="radio"/>
Remark					