Deutsches Institut für Bautechnik

DIBt

General Technical Approval

Approval Body for Construction Products & Types
Construction Engineering Inspection Body
Public-law agency jointly held by the Federal German Government and the German state governments

Member of EOTA, UEAtc and WFTAO

Date: 20/10/2017

Reference no.: III 54-1.42.3-47/17

Approval No:
Z-42.3-488

Valid
from: **20 October 2017**
until: **20 October 2022**

Applicant:
Trelleborg Pipe Seals Duisburg GmbH
Dr. Alfred-Herrhausen-Allee 36
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Object of Approval:
Cured-in-place-pipe liner known as "epros®DrainLiner" for the rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure within a nominal diameter range of DN 50 to DN 200

The above mentioned object of approval is hereby granted general technical approval.
The present General Technical Approval covers 19 pages and 36 appendices.

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I GENERAL PROVISIONS

1 The General Technical Approval is proof of the usability or applicability of the object of approval for the purpose of the German Lands' building regulations.

2 This Approval shall be no substitute for the permits, consents and certificates statutorily prescribed for the implementation of building projects.

3 This Approval is granted without prejudice to any third-party rights including but not limited to private proprietary rights.

4 Manufacturers and distributors of the object hereof shall, notwithstanding any additional regulations laid down in the "Special Provisions" chapter, provide the user of said object with copies of this Approval and shall instruct the user to the effect that this Approval must be kept at the point of use or application. Copies hereof shall also be provided to the authorities interested whenever requested by them.

5 The present Approval may not be reproduced unless in total. Any publication of part of this Approval shall require the consent of the German Institute for Construction Engineering. Texts and drawings in advertising materials shall not be contradictory to this Approval. Translations of this Approval must contain the information that the "translation of the German original version has not been verified by the German Institute for Construction Engineering".

6 This Approval is granted subject to revocation. The provisions hereof can be amended by subsequent modifications or additions, especially where required by new technical findings.

7 This Approval is based on the statements made and documents provided by the Applicant. Any change in said basis is not covered by this Approval and requires immediate disclosure to the German Institute for Construction Engineering.

8 This Approval also includes a general design certification (type approval). The general design certification within the present Approval shall be deemed the general technical approval for the design type.

Deutsches Institut für Bautechnik DIBt

General Technical Approval

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II SPECIAL PROVISIONS

1 Object of approval and scope of application

This General Technical Approval applies to the manufacture and use of cured-in-place-pipe (CIPP) liners known as "epros®DrainLiner" (Appendix 1) comprising the epoxy resin systems named "epros®EPROPOX HC60", "epros®EPROPOX HC120" and "epros®EPROPOX HC120+", and the polyester needle felt tubes named "epros®DrainFlexLiner", "epros®DrainPlusLiner", and "epros®DrainSteamLiner".

The polyester needle felt tube may comprise three different film coating variants (refer to Appendix 1 item 3):

Variant	**a)**	"epros®DrainFlexLiner"	DN 100 to DN 200	PP-coated
Variant	**b)**	"epros®DrainPlusLiner"	DN 50 to DN 200	PUR-coated
Variant	**c)**	"epros®DrainPlusLiner"	DN 50 to DN 200	silicone-coated
Variant	**d)**	"epros®DrainSteamLiner"	DN 100 to DN 200	PP-coated as component part of liner tube

The intended use of the CIPP liners is the rehabilitation by relining of defective wastewater piping systems such as sanitary pipes, rainwater downpipes and house drains inside the building structure according to DIN1986-100[1].

In case of buried pipes being relined, the provisions of the General Technical Approvals No. Z-42.3-375 and Z-42.3-468 shall apply in addition. This Approval applies to the rehabilitation of drainage and sewage pipes intended for the discharge of wastewater in accordance with DIN 1986-3[2]. The temperature of the wastewater shall not exceed the values set forth in DIN EN 476[3].

The tube liner material is fire-rated B2 according to DIN 4102-1[4] (material class B2 = normal flammability).

Defective drainage pipes are rehabilitated by the introduction and subsequent steam cure of an epoxy resin-wetted polyester needle nonwoven (felt) tube.

Cured-in-place pipe (CIPP) liners are approved for the rehabilitation of DN 50 to DN 200 drainge pipes with circular cross-section made of fibre cement and cast iron as well as drainage pipes made of the plastic materials GRP, PVC-U, PE-HD without fire stop penetration seals, or with fire stop penetration seals other than intumescent seals.

It is not allowed to reline plastic drainage pipes (GRP, PVC-U, PE-HD) having intumescent penetration seals, which would develop foam in case of a fire (e.g. wall sleeves).

Typically, vertical pipes (downpipes) are lined from the roof through the vent pipe, the building sewers through the inspection holes or cleaning eyes, and the connecting pipes through the sanitary laterals. The liner allows for the rehabilitation of up to two diameter changes and several bends or horizontal runs up to 90 degrees.

For reconnection of lateral pipes and house drains to sanitary equipment, a hat profile technique known as the "epros®DrainLCR-B system" with the "epros®DrainLCR-B or LCR-S hat profile" is used.

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1 DIN 1986-100 Drainage systems on private ground – Part 100: Specifications in relation to DIN EN 752 and DIN EN 12056; issue:2016-12

2 DIN 1986-3 Drainage systems on private ground – Part 3: Rules for operation and maintenance; issue 2004-11

3 DIN EN 476 General requirements for components used in drains and sewers; German version EN 476:2011; issue:2011-04

4 DIN 4102-1 Fire behaviour of building materials and building components - Part 1: Building materials; concepts, requirements and tests; issue:1998-05 in connection with Correction 1; issue:1998-08

2 Provisions regarding the building products

2.1 Properties and composition

2.1.1 Materials of the liner components

2.1.1.1 Materials for the inversion tubes (Appendix 1)

The materials of the polyester needle felt tube, the coatings made of PUR, silicone or PP films, and the materials of the epoxy resins, hardeners or other materials are in compliance with the formulation data kept with the German Institute for Construction Engineering (DIBt).

The liner components have the following properties:

1. The polyester needle felt tube has e.g. the following properties:

a) "epros®DrainFlexLiner" DN 100 to DN 200 – PP-coated:

Mass per unit area:	see Table A in Appendix 2
PP layer thickness:	0.30 mm to 0.40 mm

b) "epros®DrainPlusLiner" DN 50 to DN 200 – PUR coated:

Mass per unit area:	see Tables B and C in Appendix 3
PUR layer thickness:	0.20 mm to 0.25 mm

c) "epros®DrainPlusLiner" DN 50 to DN 200 – silicone coated:

Mass per unit area:	see Tables D and E in Appendix 4
Slicone layer thickness:	0.45 mm to 0.75 mm

d) "epros®DrainSteamLiner" DN 100 to DN 200 – PP coated:

Mass per unit area:	see Table A in Appendix 2
PP layer thickness:	0.40 mm to 0.60 mm

2. Two-component resin system "epros®EPROPOX HC60"

a) The epoxy resin component A of the two-component resin system "epros®EPROPOX HC60" has the following initial properties before application:

Density at +23°C:	1.16 g/cm³ ± 0.02 g/m³
Viscosity at +25°C:	11,000 mPa x s ± 1,500 mPa x s

b) The hardener component B of the two-component resin system "epros®EPROPOX HC60" has the following initial properties before application:

Density at +23°C:	0.95 g/cm³ ± 0.02 g/m³
Viscosity at +25°C:	250 mPa x s ± 75 mPa x s

c) The epoxy resin system "epros®EPROPOX HC60 (A+B)", in the cured condition without the polyester needle felt tube, has the following properties after DIN 16946-2[5] (Type 1040-0):

Density at +23°C:	1.15 g/cm³ ± 0.02 g/cm³
Flexural modulus:	approx. 2,800 N/mm²
Flexural stress σ_{fB}:	approx. 110 N/mm²
Tensile strength:	approx. 70 N/mm²
Elongation at tear:	> 7%

[5] DIN 16946-2 Reaction Resin Moulded Materials; Moulded Casting Resin Materials, Types; issue:1989-03

Heat deflection temperature according to DIN EN ISO 75-2[6] approx. 95 °C
Reactivity (pot time) at +25°C: 60 min

Table 1: Mixing viscosity "epros®EPROPOX HC60 (A+B)"

Test temperature	Viscosity [mPas] at		
	10 min after mixing (start value)	60 min after mixing (end of pot time)	70 min after mixing (end of measurement)
10°C	20600	29762	32982*
15°C	9517	15525	17522*
20°C	4839	9724	11356
25°C	2617	7315	9265

*The viscosities of the mixture measured at 10°C and 15°C were determined by extrapolation starting at 60 minutes or 53 minutes, respectively. Due to the low test temperatures, the measurements at 10°C and 15°C are distorted by condensation effects starting shortly before the end of the test period.

3. Two-component resin systems "epros®EPROPOX HC120" and "epros®EPROPOX HC120+"

a1) The epoxy resin component A of the two-component resin system "epros® EPROPOX HC120" has the following initial properties before application:
Density at +23°C: 1.16 g/cm³ ± 0.02 g/m³
Viscosity at +25°C: 3,250 mPa x s ± 650 mPa x s

a2) The epoxy resin component A of the two-component resin system "epros® EPROPOX HC120+" has the following initial properties before application:
Density at +23°C: 1.23 g/cm³ ± 0.02 g/m³
Viscosity at +25°C: 5,250 mPa x s ± 1,250 mPa x s

b) The hardener component B of the two-component resin systems "epros®EPROPOX HC120" and "epros®EPROPOX HC120+" has the following initial properties before application:
Density at +23°C: 0.96 g/cm³ ± 0.02 g/m³
Viscosity at +25°C: 275 mPa x s ± 75 mPa x s

c) The epoxy resin system "epros®EPROPOX HC120" and "epros®EPROPOX HC120+", in the cured condition without the polyester needle felt tube, has the following properties after DIN 16946-2[5] (Type 1040-0):
Density at +23°C "epros®EPROPOX HC120": 1.15 g/cm³ ± 0.02 g/cm³
Density at +23°C "epros®EPROPOX HC120+" : 1.18 g/cm³ ± 0.02 g/cm³
Flexural modulus: approx. 2,900 N/mm²
Flexural stress σ_{fB}: approx. 120 N/mm²

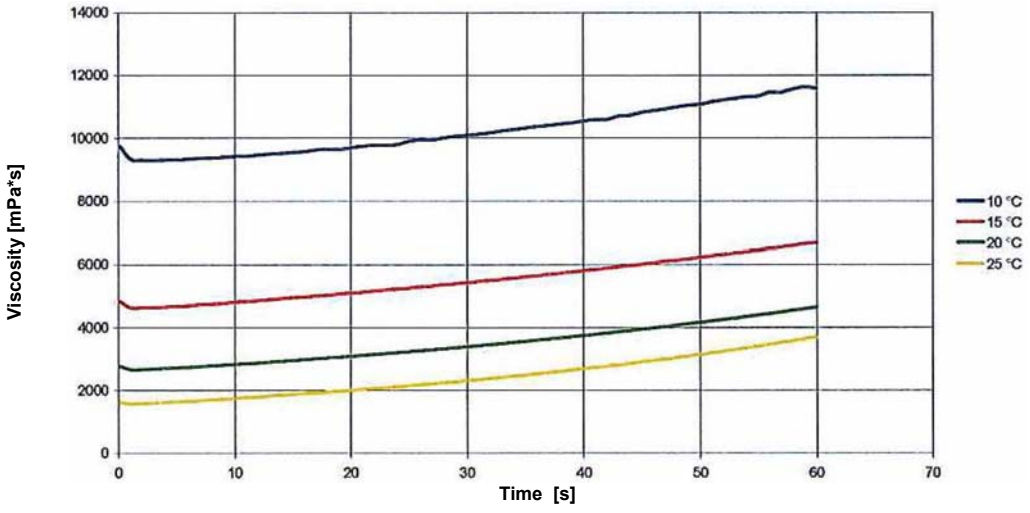
[6] DIN EN ISO 75-2 Plastics – Determination of temperature of deflection under load – Part 2: Plastics and ebonite (ISO 75-2:2004); German version EN ISO 75-2:2004; Issue:2004-09

Tensile strength:	approx. 70 N/mm²
Elongation at tear:	> 7%
Heat deflection temperature according to DIN EN ISO 75-2[6] "epros®EPROPOX HC120"	approx. 92 °C
Heat deflection temperature according to DIN EN ISO 75-2[6] "epros®EPROPOX HC120+"	approx. 99 °C
Reactivity (pot time) at +25°C:	120 min

Table 2: Mixing viscosity "epros®EPROPOX HC120 (A+B)"

Test temperature	Viscosity [mPas] at		
	10 min after mixing (start value)	60 min after mixing	70 min after mixing (end of measurement)
10°C	7698	10491	11189
15°C	4144	6318	6976
20°C	2259	3968	4520
25°C	1340	3017	3644

Chart 1: Mixing viscosity of resin system "epros®EPROPOX HC120+ (A+B)"



No resins other than epoxy resins (EP resins) of the type 1040-0 as laid down in DIN 16946-2[2] shall be used, and they must conform to the formulation data and IR spectrums kept with the German Institute for Construction Engineering. The IR spectrums shall also be kept with the independent inspection body.

2.1.1.2 Materials for the “epros®DrainLCR-B system” using the "epros®DrainLCR-B or LCR-S hat profile"

The materials for the "epros®DrainLCR-B or epros®DrainLCR-S hat profile" conform to the formulation data kept with the German Institute for Construction Engineering (DIBt). The formulations of the resin systems “epros®EPROPOX HC60” and “epros®EPROPOX HC120” as well as “epros®EPROPOX HC120+” conform to the IR spectrums kept with DIBt. The IR spectrums shall also be kept with the independent inspection body.

2.2 Manufacture, packaging, transport, storage and identification

2.2.1 Manufacture of liner tubes in factory

The polyester needle felt tubes with the minimum wall thicknesses from approx. 3 mm to approx. 6 mm (Appendices 2 to 4) shall be manufactured with an outer flexible PUR, silicon or PP film in the sub-supplier’s factory. The Applicant shall check to make sure the specified lengths and wall thicknesses are observed by the sub-supplier.

The Applicant shall request appropriate proof for verifying that the properties of the resins and the hardeners, the fillers or other additives are in accordance with the formulation data.

The following properties shall be checked during the incoming goods inspection:

Properties of the resins:

– Density
– Viscosity

2.2.2 Packaging, transport, storage

The polyester needle felt tubes with a one-sided coating as delivered by the sub-supplier shall be stored in the premises of the Applicant until further use in a way to ensure the tubes will not be damaged.

The components delivered by the sub-supplier for resin impregnation on the specific job site shall be stored until further use in suitable and separate hermetically closed containers in the premises of the Applicant. The temperature range between approx. +15°C and approx. +35°C shall be observed. The shelf life for the epoxy resins and the hardeners is about 12 months after delivery and shall not be exceeded. The containers shall be protected from direct sunlight. They shall be designed such that the epoxy resins and the hardeners are kept in separate receptacles.

The usage amounts of each component required for the rehabilitation jobs shall be withdrawn from the storage containers and then transported in safe, separate and hermetically closed receptacles to the given place of application. There, the transport containers must be protected from weather. The polyester needle felt tubes shall be transported in suitable containers ensuring they are not damaged.

The relevant rules and regulations of accident prevention as well as the instructions given in the Applicant’s method statement shall be observed.

2.2.3 Identification/labelling

The polyester needle felt tubes and the transport containers of the resin components shall be identified with the compliance mark (“Ü”) in accordance with the applicable compliance and conformity regulations of the German *Länder*, inclusive of the Approval number Z-42.3-488. Said identification is subject to the condition that the requirements set forth in Section 2.3 Proof of Compliance have been met.

The manufacturer shall indicate the hazard-related symbols and H and P phrases laid down in the German Hazardous Substances Ordinance (GefStoffV) and the European Regulation

No. 1907/2006 (REACH), as well as in the CLP Regulation (EC) 1272/2008[7] as revised from time to time. The packaging shall be labelled according to the rules of ADR[8] as revised from time to time.

In addition, the transport containers of the polyester needle felt tubes shall show:

– Nominal diameter
– Length
– Batch number
– PUR, silicone or PP film coatings
– Reference to PP film as component part of the liner

In addition, the transport containers for resins, hardeners and other additives shall be identified with at least the following information:

– Resin designation “epros®EPROPOX HC60” or “epros®EPROPOX HC120” or “epros®EPROPOX HC120+”
– Component designation A and B
– Temperature range
– Quantity contained (volume or weight)

2.3 Proof of Compliance

2.3.1 General

The confirmation that the liner tubes and hat profiles (construction products) are in compliance with the provisions of this General Technical Approval must be provided for each manufacturing factory by means of a Declaration of Compliance based on in-house production control and a Compliance Certificate issued by an accredited certification body, and based on regular third-party inspection by an accredited inspection body, including initial testing of the construction products subject to the following conditions.

For obtaining the Compliance Certificate and for third-party inspection including the product tests associated therewith, the manufacturer of the construction products shall commission a certification body and an inspection body accredited for this purpose, respectively.

To confirm the issuance of a Compliance Certificate, the manufacturer shall label the construction products with the compliance mark ("Ü”) while indicating the intended use.

The certification body shall provide one copy of its Compliance Certificate to the German Institute for Construction Engineering for information.

In addition to that, the German Institute for Construction Engineering shall be given for information a copy of the initial test report.

2.3.2 In-house production control

Each manufacturing plant shall implement and carry out in-house production control. In-house production control shall mean the continuous inspection or monitoring of the production by the manufacturer to ensure that the construction products made by the manufacturer comply with the provisions of this General Technical Approval.

In-house production control should include the following minimum requirements:

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7 1272/2008 Regulation (EC) No. 1272/2008 on classification, labelling and packaging of substances and mixtures

8 ADR European Agreement concerning the International Carriage of Dangerous Goods By Road (*Accord européen relatif au transport international des marchandises Dangereuses par Route*)

– Description and inspection of the base material

  For each delivery of the incoming components of PUR, silicone or PP films, polyester fibre, resins, hardeners or other additives, the operator of the manufacturing plant shall check and make sure the properties required under Section 2.1.1 are met.

  For this purpose, the operator of the manufacturing plant shall cause each of the respective sub-suppliers to submit certificates of compliance 2.1 after DIN EN 10204[9]. In addition, the incoming goods inspection shall include a random check verifying the properties specified in Section 2.1.1 hereof in accordance with the methods kept with the German Institute for Construction Engineering.

– Checks and inspections to be performed during manufacture:

  It is to be checked that the requirements laid down in Section 2.2.1 are fulfilled.

– Inspection of containers:

  Check every resin batch for meeting the labelling requirements set forth in Section 2.2.3.

The results of the in-house production controls shall be recorded and evaluated. The records shall contain at least the following information:

– Designation of the construction product or base product and its components,
– Type of control or inspection,
– Date when the construction products or base materials were manufactured and inspected,
– Result of the control checks and inspections and, where appropriate, comparison with the requirements,
– Signature of the person responsible for in-house production control.

The records shall be kept for at least five years and submitted to the external inspection body commissioned for third-party inspection. If so requested, the records shall be submitted to the German Institute for Construction Engineering and to the competent supreme building inspection authority.

If the inspection result is not satisfactory, the manufacturer shall immediately take the actions required for correcting the defect. Non-conforming construction products shall be handled in a way to ensure no confusion with conforming products is possible. Once the defect has been corrected, the failed test or inspection shall be repeated immediately – where technically feasible and required for proving the success of the corrective action.

2.3.3 Third-party inspection

In every manufacturing plant, the in-house production control system shall be inspected and verified by an external body at regular intervals, but at least once every six months.

The scope of third-party inspection includes a first inspection (initial testing) of the method components. In-house production control shall be performed on the basis of random checks within the scope of third-party inspection. The control checks shall verify compliance with the requirements under Sections 2.1.1 and 2.2.3.

Furthermore, there shall be random checks for compliance with the manufacturing requirements laid down in Section 2.2.1. These shall include the verification of the curing behaviour, density, storage stability, and mass per unit area, as well as IR spectroscopies.

In each case, the accredited inspection body is responsible for sampling and testing. During third-party inspection, the certificates of compliance 2.1 and test reports 2.2 after DIN EN 10204[9] shall be verified as well.

[9] DIN EN 10204 Metallic products – Types of inspection documents; German version EN 10204:2004; issue: 2005.01

The results of the certification and third-party inspection processes shall be kept for no less than five years. If so requested, they shall be submitted by the certification body or inspection body to the German Institute for Construction Engineering and to the competent supreme building inspection authority.

3 Provisions for the application of the object of approval

3.1 Planning and dimensioning

3.1.1 Planning

An inspection according to DIN EN 1986-3[1] shall be performed to determine whether the defects in the drainage system can be repaired with the "epros® DrainLiner". The necessary pipeline data shall be verified and documented, e.g. pipe material, routing and pipe length, bends and nominal diameters, location of the roof-top vent pipes and cleaning holes, hydraulic conditions, previous repairs, or location of laterals no longer required.

Existing video takes must be evaluated in relation to a given application. The accuracy of the data must be verified on the job site. The condition of the existing pipeline must be assessed to determine the applicability of the "epros®DrainFlexLiner", "epros®DrainPlusLiner", and "epros®DrainSteam Liner".

Especially, it is important to evaluate the fire safety requirements of the pipe sections to be renovated on a case-by-case basis.

It is not allowed to line drainage pipes having intumescent penetration seals. The fire safety provisions and requirements of the regional German states for pipe systems shall be observed.

The hydraulic capacity of the drainage pipes shall not be affected by the installation of a liner. If necessary, appropriate proof shall be furnished.

3.1.2 Dimensioning

3.1.2.1 Wall thicknesses

The post-cure wall thicknesses range between 2 mm and 6 mm.

3.1.2.2 Fire behaviour

The cured liner meets the requirements defined for construction material class B2 – normal flammability – according to DIN 4210-1[4].

3.1.2.3 Characteristics of the cured polyester fibre/resin composite from thermal analysis (DSC analysis)

The cured polyester fibre/resin composite shows the following limit values as determined by means of Differential Scanning Calorimetry (DSC):

- **"epros®EPROPOX HC60"**

Glass transition temperature T_{G1}	(actual condition of the reaction resin system; first heating phase)
approx. +96 °C	
Glass transition temperature T_{G2}	(resin system in its fully cured condition; second heating phase)
approx. +106 °C	

- **"epros®EPROPOX HC120" and "epros®EPROPOX HC120+"**

  Glass transition temperature T_{G1} (actual condition of the reaction resin system; first heating phase)

  approx. +45 °C

  Glass transition temperature T_{G2} (resin system in its fully cured condition; second heating phase)

  approx. +103 °C

3.2 Execution of works

3.2.1 General

All pipe runs to be renovated shall be taken out of service before the lining operation is started. Prior to processing the components, it shall be ensured that the components, the drainage system and its surroundings show the processing temperatures specified by the manufacturer.

Drainage lines in need of repair are rehabilitated by installing and then curing an epoxy resin-wetted polyester needle felt tube.

For this purpose, a polyester needle felt tube coated with an exterior polyurethane film (PUR), silicone film, or polypropylene (PP) film coating is wetted with epoxy resin.

In the cured-in-place pipe (CIPP) lining method using a liner tube with a closed end (closed-end method), the polyester needle felt tube is inverted by means of compressed air into the defective drainage pipe. Curing is by steam. In the open-end method, a calibration hose tube is inverted additionally or simultaneously. (An alternative approach is to used an "epros®LinerEndCap" instead of the calibration hose. The end cap will be glued onto the end of the liner tube and removed after final cure.)

The liners shown in Section 2.1 allow DN 50 to DN 200 pipes to be rehabilitated.

The "epros®DrainLiner" method can be applied in the following structural conditions (Appendices 10 and 11):

a) Lining of vertical pipe runs (downpipes) from the roof through the vent pipe
b) Lining of building sewers through inspection holes or cleaning eyes
c) Lining of connection pipes through sanitary laterals

The basic condition is that the size of the access openings is sufficient for setting up the inversion drum and placing the inversion fitting of the inversion plant.

It is possible to renovate a pipeline including up to two diameter changes and several bends or horizontal runs up to 90 degrees.

To reconnect the lateral pipes and house drains to sanitary equipment, the lined pipe will be re-opened by means of a remote-controlled cutter robot. The connection will made by means of the hat profile technique known as "epros®DrainLCR-B or LCR-S hat profile". If the liner is sufficiently bonded to the host pipe, a waterproof connection can be made without any additional sealing step.

The Applicant shall prepare a manual describing each of the steps to be carried out according to the type of performance of the lining method.

The Applicant shall also ensure installers are sufficiently familiarised with the method.

The Applicant shall provide the installer with the IR spectroscopies.

The required steps for operating the method shall be recorded for each impregnation and each lining operation with the help of report forms (e.g. Appendices **30** to **35**).

3.2.2 Equipment and installations

3.2.2.1 Minimum needs in equipment, components and installations required for implementing the lining method:

- Cleaning equipment for small to medium pipe diameters (pipe materials sensitive to abrasives shall be cleaned with appropriate soft brush or sponge attachments or by jetting)
- Equipment for visual inspection
- Polyester needle felt tubes in the appropriate nominal diameters (Appendix 1): "epros®DrainFlexLiner" DN 100 to DN 200, "epros®DrainSteamLiner" DN 100 to DN 200, and/or "epros®DrainPlusLiner" DN 50 to DN 200
- Heat and pressure-resistant calibration hoses according to the given nominal diameters
- "epros®LinerEndCap"
- Containers with resin (component A) and hardener (component B) of the resin systems "epros®EPROPOX HC60" and/or "epros®EPROPOX HC120" and/or "epros®EPROPOX HC120+"
- Equipment for dosing and mixing the resin system (Appendix 24)
- Weatherproof impregnation point (table with belt conveyor or roller table and pinch roller system) with exhaust system where required (Appendix 24)
- Vacuum system (Appendix 24)
- "epros®InversionDrum"
- "epros®SteamGen" steam generator with "epros®SteamTelemetry" (semi-automatic control) and/or "epros®SteamMixingLance" (hand control) and accessories for steam cure
- Heat and pressure-resistant pressure hoses for connection to the inversion drum according to the given nominal diameter
- Steam temperature monitoring devices
- Pressure gauge
- Steam outlet
- Compressor, air hoses, air pressure regulator
- Where required: blind plugs in the range between DN 50 and DN 200 (steam inlet plugs)
- Inflatable epros® pipe plugs or epros® stop discs for the given nominal diameter
- Water supply
- Power supply
- Containers for residues and waste material
- Temperature sensors
- Temperature monitoring and recording device
- Small equipment
- Pneumatic drill
- Hand tools, ropes
- Social and sanitary rooms, where required

3.2.2.2 Additional components, equipment and installations for lateral connection repairs

Minimum needs in components, equipment and installations required for the lining of lateral connections with the "epros®DrainLCR-B system" in addition to the items mentioned in Section 3.2.2.1:

- "epros®DrainLCR-B or S hat profile" in the respective nominal diameters
- Lining equipment ("epros®DrainLCR packer") and accessories
- Control box ("epros®LCR-B")
- Containers with resin (component A) and hardener (component B) of the resin systems "epros®EPROPOX HC60" and/or "epros®EPROPOX HC120" and/or "epros®EPROPOX HC120+" and/or "epros®ResinType W01" and/or "epros®ResinType W1" and/or "epros®ResinType S" according to the General Technical Approval No. Z-42.3-385
- Weatherproof impregnation point, equipment and devices for mixing the resin systems
- Steam generator ("epros®SteamGen")
- Interlocking air push rods
- Camera, control box with monitor

3.2.3 Performance of lining operation

3.2.3.1 Collection of required pipe data

Before the work is started, the required pipeline data shall be obtained with an inspection camera according to sections 3.1 and 3.2.

3.2.3.2 Preparation and cleaning of the pipe system

As drain traps or entire sanitary items are removed for the CIPP lining operation with the need to prevent bad odours or germs from penetrating into residential rooms, the exhaust system (blower) shall be connected to the roof-mounted vents and set into operation. The working zone shall be protected from dirt and contamination by appropriate sheeting material. The installer shall ensure there is no sewage flow into the pipe system to be relined.

Then the host pipes shall be cleaned by mechanical or hydromechanical means. An inspection camera shall be introduced for checking and evaluating the cleaning result to make sure the host pipe condition is sufficient for the lining operation. If additional cleaning is required, additional cleaning tools should be selected as appropriate or required for the prevailing condition of the drainage pipes (material, dirt or corrosion level). The cleaning results shall be checked with the help of the camera. The cleaning operation must be repeated until no loose material or debris remain on the inner surface of the drainage pipe.

The actual post-cleaning condition shall be documented with the help of a video-recording camera. Holes and cracks not visible before the removal of the debris and incrustations shall be reported.

All relevant rules and regulations of accident prevention shall be observed in each step of the lining process.

Specifically, where steam generators and steam cure equipment are used, the Machinery Safety Act and the Steam Boiler Ordinance shall be observed.

3.2.3.3 Inspection of incoming method components on the job site

The transport containers of the lining components shall be checked for proper identification as specified in Section 2.2.3. The circumference of the polyester needle felt tube as referred to the host pipe shall be verified by measuring it before the tube is wetted with resin. Also, the pre-impregnation storage temperature to be maintained between +15°C and +35°C shall be verified.

3.2.3.4 Impregnation of polyester needle felt tube

a) Epoxy resin mixture for the "epros®DrainFlexLiner", "epros®DrainSteamLiner" and "epros®DrainPlusLiner"

The resin usage amount required for wetting a given polyester needle felt tube shall be determined according to the liner material, diameter, wall thickness and length before the resin is mixed (Appendices 5 to 7).

The mixing ratio between the "epros®EPROPOX HC60" or "epros®EPROPOX HC120" epoxy resin and the hardener is 100:33 kg by weight, or 100:40 Litres by volume (Appendix 5).

The mixing ratio between the "epros®EPROPOX HC120" or "epros®EPROPOX HC120+" epoxy resin and the hardener is 100:33 kg by weight, or 100:40 Litres by volume (Appendices 6 and 7).

Once the container has been opened, the full amount of hardener must be added immediately to the resin. A double stirrer (electrically or air-operated) shall be used to uniformly mix the hardener component with the epoxy resin without bubbles in the resin container (at least for 3 minutes). An automatic dosing and mixing unit shall be used for larger usage amounts of approx. 180 Litres or more.

The resin mixture as well as the temperature conditions shall be recorded in the report according to Section 3.2.1.

A sample shall be taken from every resin batch to verify and report its reactivity.

b) Wetting with resin

The polyester needle felt tube shall be unrolled and placed on the conveyor table, or suspended from appropriate installations, in the weatherproof or air-conditioned room, or in the CIPP truck. Each component must be thoroughly mixed in itself before the components are mixed together. The mixing temperature shall never fall below +15°C. For better wetting, it is necessary to remove most of the air contained in the polyester needle felt tube. An appropriate negative pressure of no more than 0.5 bar in the polyester needle felt tube can be achieved by means of the following methods:

1. For shorter lengths, a vacuum incision shall be cut into the top coating at the end of the liner tube. Never cut the seam area. But at least three incisions of about 15 mm shall be made. They shall be in the coating only and will accommodate the suction cup of the vacuum unit.
2. For greater lengths or liner diameters, vacuum incisions shall be made at intervals of 15 m to 20 m in the top coating, but not in the seam area. At least three incisions of some 15 mm shall be cut into the coating only. The cuts not used for the moment shall be covered with an adhesive tape. They will be used later and finally be closed.

Then the liner tube shall be folded into a "Z" shape. A weight shall be placed onto the "Z"-fold to hold it down. This helps a negative pressure build up between the folded liner and the suction cups. Another Z-fold shall be made behind every suction cup with a weight being placed on it. The open end of the liner shall be placed on the impregnation table and the resin mixture shall be poured into it. To achieve uniform distribution of the resin inside the polyester needle felt tube, the liner shall then be passed through a pinch roller

system. For this purpose, the liner tube shall be placed under the pressing rollers. The nip shall be set to twice the wall thickness of the liner tube plus 2 mm. The related operating and maintenance instructions shall be provided to, and observed by, the installer.

The feed rate shall be selected so as to achieve uniform distribution of the resin in the matrix of the polyester needle felt tube. The line speed of the impregnation process depends on the suction or penetration behaviour of the resin mixture. If the resin distribution is visibly inhomogeneous, the impregnation rate should be reduced or the vacuum be adjusted.

For less friction during the following inversion step and for avoiding unnecessary temperature increases, the impregnated liner tube coming from the pinch rollers shall immediately be folded into a container with a biodegradable lubricant.

The cure time and the temperature curve shall be recorded in the report according to Section 3.2.1 both for closed-end inversion and for open-end inversion.

3.2.3.5 Inversion of the resin-wetted polyester needle felt tube (Appendices 8 and 9)

Once the impregnation process is complete, the end of the liner tube together with the control tape shall be tied together (to form the “liner head”) and wound into the inversion drum. For inversion, the still open end of the liner tube shall be passed through the inversion tube to be connected to the inversion drum. This shall be done by means of a pull rope. The tube end shall be attached to the pre-mounted “epros®InversionFitting” or “epros®Inversion Bend” by means of clamps.

3.2.3.5.1 Inversion according to the closed-end method (Appendices 12 and 13)

Step 1: Inversion by means of inversion drum

The “epros®InversionFitting” or “epros®InversionBend” shall be introduced with the liner end into the access hole or pipe opening and positioned at the beginning of the host pipe. Then the inversion pressure specifically indicated for a given liner diameter and wall thickness shall be applied to the inversion drum according to Appendices 19 to 22. The pressure causes the liner tube to be inverted. The inversion process continues until the inspection hole or exit point of the host pipe is reached. As a result of this process, the resin-wetted interior side of the liner tube either enters into contact either with the interior side of the PE preliner or into direct contact with the inner surface of the host pipe. So the PUR, silicon or PP film is turned to the side of the service flow.

Step 2: Steam cure

Compressed air shall be used to keep the curing pressure constant at the values specified in the Appendices 25 to 29 by means of the “epros®SteamTelemetry” (semi-automatic control) or “epros®SteamMixingLance” (hand control). The steam generator shall be started and, after the appropriate heating-up period, connected to the “epros®SteamTelemetry” or “epros®SteamMixingLance” unit. The temperature shall be continuously increased by adding the appropriate amount of steam via the “epros®SteamTelemetry” or “epros®SteamMixing Lance”. The steam/air mixture shall exit the liner through the “epros®SteamOutlet valve” at the end of the liner tube. The maximum steam/air temperature of +100°C shall never be exceeded.

Both the temperature of the steam/air mixture and the temperature between the liner and the inner wall of the host pipe (at the entry and exit points, or pipe opening) shall be measured at the invert (lowest point) and reported during the entire cure period. The curing temperatures shall be recorded between the inverted liner tube and the inner pipe wall surface of the drainage line.

The curing times according to Tables 3 and 4 shall be observed.

Table 3: Curing times of the epoxy resin system "epros®EPROPOX HC60"

Curing times in minutes	Curing temperatures in °C
approx. 90	at +80°C for steam

Table **4**: Curing times of the epoxy resin system "epros®EPROPOX HC120" and "epros®EPROPOX HC120+"

Curing times in minutes	Curing temperatures in °C
approx. 120	at +80°C for steam

After final cure (completion of the heating phase), the liner tube shall be cooled down with air to reach a liner temperature of +20°C.

The curing times for the "epros®DrainFlexLiner", "epros®DrainSteamLiner" and "epros®DrainPlusLiner" (Tables 3 and 4) are variable depending on the epoxy resin system selected among those mentioned at Section 2.1.1 and on the prevailing ambient temperatures. The curing time and the applied pressure shall be measured and reported during the entire cure period.

3.2.3.5.2 Inversion according to the open-end method (Appendices 14 and 21)

Step 1: Inversion by inversion drum

Where the lining operation starts from an inspection hole towards an inaccessible house drain pipe, the liner length shall be determined in advance to prevent the liner from protruding into such pipe. The end of the liner tube must be closed with a Teflon tape or an elastic rubber band before the liner is wound up.

The liner tube such taped shall be wound into the inversion drum. The next operations are the same as those described in sub-section 3.2.3.5.1 at Step 1.

At the end of the air-supported inversion process, the Teflon tape or rubber band will get loose and release the pressure from inside the liner. At this point, the liner is not yet in contact with the inner surface of the host pipe, or PE preliner installed before.

The liner tube shall be detached from the "epros®InversionFitting" or "epros® InversionBend". A calibration hose with a connected heating hose and control tape shall be wound into the inversion drum. The opposite end of the calibration hose shall be attached to the "epros®InversionFitting" or "epros®InversionBend". Then the calibration hose shall be inverted at the same pressure level as that mentioned at 3.2.3.5.1 Step 1. The calibration hose forces the liner against the inner wall of the host pipe in a close and tight fit.

Step 2: Steam cure

The same operations as those described in sub-section 3.2.3.5.1 at Step 2 shall be performed.

3.2.3.5.3 Inversion with open end and "epros®LinerEndCap" (open-end method, Appendices 14 and 15)

Step 1: Inversion by inversion drum

Where the lining operation starts from an inspection hole towards an inaccessible house drain pipe, the liner length shall be determined in advance to prevent the liner from protruding into such pipe. The "epros®LinerEndCap" shall be attached to the end of the liner tube before impregnation.

Either the steam outlet valve or the heating hose shall be connected to the "epros®LinerEndCap". The liner tube such closed shall be wound into the inversion drum. The next operations are the same as those described in sub-section 3.2.3.5.1 at Step 1.

Step 2: Steam cure

The same operations as those described in sub-section 3.2.3.5.1 at Step 2 shall be performed.

After completion of the cooling-down phase, the "epros®LinerEndCap" shall be removed from the cured liner with the help of the control tape.

3.2.3.6 Final operations

After curing, the ends of the new inner pipe shall be cut off flush with the pipe wall, inspection hole or cleaning eye by means of pneumatically operated cutting tools and be removed.

The cutting work shall be performed in compliance with the relevant rules and regulations of accident prevention.

3.2.3.7 Restoring lateral connections

Lateral and house drain connections to downpipes shall be waterproof.

To reconnect the lateral pipes and house drains to sanitary equipment, the lined pipe shall be re-opened by means of a remote-controlled cutter unit. The lateral connections shall be restored by means of the hat profile technique of the "epros®DrainLCR-B method" (Appendices 22 and 23). If the liner is sufficiently bonded with the host pipe, a waterproof connection can be made without any additional sealing step.

The lining project owner is responsible for ensuring that the pipe connection interfaces are properly sealed for waterproof performance.

3.2.3.7.1 Mixing the resin

The resin shall be mixed as specified in para. a) of sub-section 3.2.3.4.

3.2.3.7.2 Restoring lateral connections by installing hat profiles (Appendices 22 and 23)

Downpipe/lateral or downpipe/drain junctions masked by the inverted liner shall be cut open from inside the cured-in-place polyester needle felt tube.

Lateral pipes shall be reconnected with the help of the appropriate lining device ("epros®DrainLCR-B packer") and the "epros®DrainLCR-B or LCR-S hat profile" ("epros®DrainLCR-B hat profile": 2 mm to 3 mm wall thickness and 5 cm rim width, "epros®DrainLCR-S hat profile": 4 mm to 5 mm wall thickness and 10 cm rim width) and by means of the components, equipment and installations mentioned in sub-section 3.2.2.2.

The lining device is composed of a preformed cylindrical inflatable packer body and a lateral tube centrally located on the side surface at an angle of 45 degrees or 90 degrees. The "epros®DrainLCR-B or LCR-S hat profile" is designed as a cap to be placed onto the lateral tube of the "epros®DrainLCR-B packer". Then, the lateral tube of the "epros®DrainLCR-B packer" with the hat profile on it shall be retracted into the packer body, which shall then be pushed or pulled into the host pipe.

The "epros®DrainLCR-B or LCR-S hat profile" shall be pushed with the packer down the pipe to the point of repair by means of interlocking push rods. A camera shall be introduced from the lateral pipe to help proper positioning. Once the packer is in place, compressed air shall be applied to the packer body to cause the lateral tube carrying the "epros®DrainLCR-B or LCR-S hat profile" to be inverted down into the lateral connection

pipe or house drain. The pressure applied to the packer body with its lateral extension will be maintained until the resin mixture has hardened completely.

The curing time for the "epros®DrainLCR B or S hat profile" (tables 3 and 4) varies according to the resin system actually used and depends on the mixing ratio of the components A and B according to sub-section 3.2.3.7.1 as well as on the prevailing ambient temperatures. The curing time can be reduced by steam cure. For this purpose, a steam/air mixture (max. 100°C) shall be applied to the packer and after the curing time has elapsed the packer shall be cooled down with air.

The curing time and the applied pressure shall be recorded. After final cure, the packer shall be deflated and a vacuum shall be created (by means of the "epros®LCR B" control box) to allow the packer to be withdrawn from the sewer.

The installation of the hat profiles and the curing process shall be reported (e.g. Appendices 34 and 35).

3.2.3.8 Final inspection and tightness test

After completion of the work, the relined pipe run shall undergo optical inspection as proof there are no residues left in the line and no wrinkles impairing the hydraulic capacity.

After final cure a tightness test shall be done. The test may be performed section by section. Water tightness can be verified by filling the relined pipes entirely with water.

3.2.3.9 Testing of samples

3.2.3.9.1 General

Samples shall be taken on the job site for the analysis of the characteristic material properties by means of the differential scanning calorimetry (DSC) (Appendix 36).

3.2.3.9.2 Determination of strength properties by means of DSC analysis

The on-site samples shall be subjected to a DSC analysis. The following procedure shall be complied with:

1. Cutting through the drilled core sample (diamond cut)
2. Measuring the wall thickness of the structural layer in three points
3. Qualitative assessment of the structural layer in the sawn region according to DIN 18820-3[10] Section 5.2
4. Preparation of specimen from the structural layer for DSC analysis
5. DSC analysis according to DIN 53765[11], Method A-20
6. Evaluation of test results according to Section 9.

3.2.3.9.3 Water tightness of the samples

The water tightness of the cured liner can be tested on a liner sample without protective film on specimens taken from the cured liner without film coating. For testing, the coating film of the liner test segment or specimen shall be either removed or perforated. Care shall be taken to avoid damage to the structural layer.

The test on specimens may use either a positive or a negative pressure of 0.5 bar.

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[10] DIN 18820-3 Glass fibre reinforced unsaturated polyester (GF-UP) and phenacrylic (GF-PHA) resin structural composites; Protection for structural layer; issue:1991-03

[11] DIN 53765 Testing of plastics and elastomers; Thermal analysis; Differential Scanning Calorimetry (DSC); issue:1994-03

For the negative pressure test, water shall be supplied to one end of the specimen. No visible leakage of water shall occur at the opposite end of the specimen during a load period of 30 minutes at a negative pressure of 0.5 bar.

In the positive pressure test, a water pressure of 0.5 bar shall be applied and held for a period of 30 minutes. Again, there shall be no visible leakage at the opposite end of the specimen.

3.2.3.10 Declaration of Compliance for the performed lining job

The installing company must certify that the performed relining job is in compliance with the provisions laid down in this General Technical Approval by issuing a Declaration of Compliance based on the specifications in Table 5. Said Declaration of Compliance shall be accompanied by documents showing the properties of the method components according to sub-section 2.1.1 and by the results of the tests mentioned in Table 5.

The lining job manager or a technically competent representative of the job manager shall be present on the job site during the performance of the ling operation. This person shall see to the proper execution of the work according to the provisions laid down in Section 4 and, more specifically, shall perform or arrange for the tests according to Table 5. The specified number of tests and scope of testing shall be minimum requirements.

Table 5: "Tests to be carried out during operation"

Test object	**Type of requirement**	**Testing interval**
Optical inspection of the line	according to 3.2.3.1	before each lining operation
Optical inspection of the line	according to 3.2.3.8	after each lining operation
Equipment	according to 3.2..2	each job site
Identification of containers of lining components	according to 2.2.3	
Water tightness	according to 3.2.3.8	
Resin mixture, resin usage amount & cure behaviour for each liner tube	mixing report according to 3.2.3.4	
Curing temperature and curing time	according to 3.2.3.5	
Wall structure, wall thickness	according to 3.1.2.1	
Analysis of glass transition temperatures T_{G1} and T_{G2} by means of DSC	according to 3.1.2.3 and 3.2.3.9.2	

Prof. Gunter Hoppe
Head of Department

Attested *[signature]*

[DIBt stamp]

Liner tube cross section

1. Host pipe

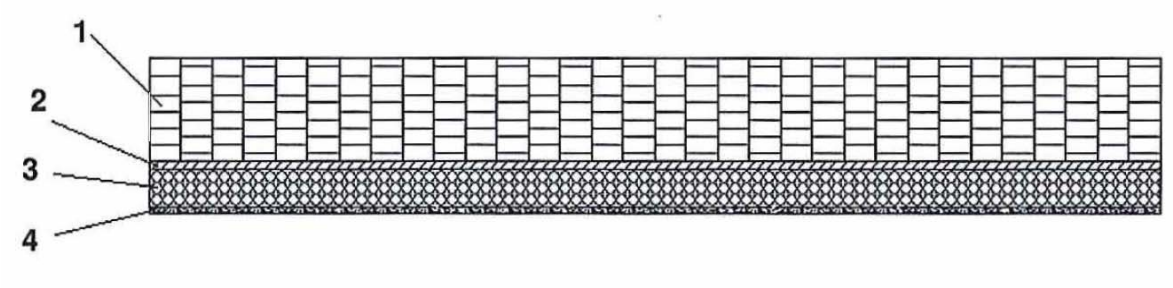
2. Preliner

3. Cured impregnated DrainFlexLiner, DrainSteamLiner, DrainPlusLiner (PUR/1.0/2.0)

4a.	for DrainFlexLiner	DN 100 - DN 200	PP coated	thickness: 0.30 – 0.40 mm
4b.	for DrainPlusLiner	DN 50 - DN 200	PUR coated	thickness: 0.20 – 0.25 mm
4c.	for DrainPlusLiner	DN 50 - DN 200	silicone coated	thickness: 0.45 – 0.75 mm
4d.	for DrainSteamLiner	DN 100 - DN 200	PP coated	thickness: 0.40 – 0.60 mm

The coatings of variants **4a.** to **4c.** are used as an installation aid for the tube liner.

The PP coating of variant **4d.** “DrainSteamLiner” is an integrated component part of the tube liner.



"CIPP liner known as "epros®DrainLiner” for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 1**
Liner tube cross section for installation inside buildings	

Table A: epros®DrainFlexLiner and epros®DrainSteamLiner

Nominal diameter	Final wall thickness	Initial wall thickness	Mass per unit area (without coating)	Liner overall weight including seam/coating 300 µm	Liner overall weight including seam/coating 500 µm	Liner overall weight including seam/coating 600 µm	Maximum deviation
DN	mm	mm	g/m²	g/m	g/m	g/m	± %
100	3	>3.0	650	303	360	388	15
100	4.5	>4.5	900	374	431	459	15
125	3	>3.0	650	371	441	477	15
125	4.5	>4.5	900	459	530	565	15
150	3	>3.0	650	438	522	565	15
150	4.5	>4.5	900	544	628	671	15
150	6	>6.0	1200	671	756	798	15
200	3	>3.0	650	572	685	742	15
200	4.5	>4.5	900	713	826	883	15
200	6	>6.0	1200	883	996	1052	15

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"

Table A: epros®DrainFlexLiner PP, epros®DrainSteamLiner PP
Properties before installation

Appendix 2

Table B: epros®DrainPlusLiner PUR with 9% undersize

Nominal diameter	Final wall thickness	Initial wall thick-ness	Mass per unit area (without coating)	Liner total weight incl. seam and coating	Maximum deviation
DN	mm	mm	g/m²	g/m	± %
50	3	>3.0	416	107	15
70	3	>3.0	416	143	15
100	3	>3.0	416	198	15
125	3	>3.0	416	244	15
150	3	>3.0	416	290	15
200	3	>3.0	416	381	15

Table C: epros®DrainPlusLiner PUR with 18% undersize

Nominal diameter	Final wall thick-ness	Initial wall thick-ness	Mass per unit area (without coating)	Liner total weight incl. seam and coating	Maximum deviation
DN	mm	mm	g/m²	g/m	± %
50	3	>3.0	416	98	15
70	3	>3.0	416	131	15
100	3	>3.0	416	180	15
125	3	>3.0	416	221	15
150	3	>3.0	416	263	15
200	3	>3.0	416	345	15

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 3**
Tables B and C: epros®DrainPlusLiner PUR Properties before installation	

Table D: epros®DrainPlusLiner 1.0 with 10% undersize

Nominal diameter	Final wall thick-ness	Initial wall thick-ness	Mass per unit area (without coating)	Liner total weight incl. seam and coating	Maximum deviation
DN	mm	mm	g/m²	g/m	± %
50	>3.0	>4.0	650	217	15
70	>3.0	>4.0	650	303	15
100	>3.0	>4.0	650	434	15
125	>3.0	>4.0	650	542	15
150	>3.0	>4.0	650	650	15
200	>3.0	>4.0	650	867	15

Table E: epros®DrainPlusLiner 2.0 with 10% undersize

Nominal diameter	Final wall thick-ness	Initial wall thick-ness	Mass per unit area (without coating)	Liner total weight incl. seam and coating	Maximum deviation
DN	mm	mm	g/m²	g/m	± %
70	>4.0	>5.0	800	336	15
100	>4.0	>5.0	800	481	15
125	>4.0	>5.0	800	601	15
150	>4.0	>5.0	800	721	15
200	>4.0	>5.0	800	961	15

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"

Tables D and E: epros®DrainPlusLiner 1.0/2.0, silicone-coated
Properties before installation

Appendix 4

Calculation of usage amounts – epros®EPROPOX HC60(A + B)

Sprache / language / langage:	German

Calculation of usage amounts

for epros®EPROPOX epoxy resins

Liner type	DrainPlusLiner PUR
Resin system	HC60
Units	metric

Diameter	100	mm
Wall thickness	3	mm
Length	4.4	m
Roller nip	8	mm

Resin mixture in total	4.15	Litres
	4.56	Kg

Volume	**Component A (resin)**	**2.96**	**Litres**
	Component B (hardener)	**1.19**	**Litres**

Weight	**Component A (resin)**	**3.43**	**Kg**
	Component B (hardener)	**1.13**	**Kg**

IMPORTANT
Please refer to the data sheet of both the liner and the resin system actually used

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 5**
Calculation of resin usage amounts epros®EPROPOX HC60	

Calculation of usage amounts – epros®EPROPOX HC120(A + B)

Sprache / language / langage:	German

Calculation of usage amounts

for epros®EPROPOX epoxy resins

Liner type	DrainFlexLiner
Resin system	HC120
Units	metric

Diameter	125	mm
Wall thickness	3	mm
Length	7.4	m
Roller nip	8	mm

Resin mixture in total	9.15	Litres
	10.03	Kg

Volume	**Component A (resin)**	**6.56**	**Litres**
	Component B (hardener)	**2.59**	**Litres**

Weight	**Component A (resin)**	**7.54**	**Kg**
	Component B (hardener)	**2.49**	**Kg**

IMPORTANT
Please refer to the data sheet of both the liner and the resin system actually used

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 6**
Calculation of resin usage amounts epros®EPROPOX HC 120	

Calculation of usage amounts – epros®EPROPOX HC120+ (A+B)

Sprache / language / langage:	German

Calculation of usage amounts

for epros®EPROPOX epoxy resins

Liner type	DrainPlusLiner 2.0
Resin system	HC120+
Units	metric

Diameter	150	mm
Wall thickness	4.5	mm
Length	11.7	m
Roller nip	11	mm

Resin mixture in total	24.81	Litres
	28.82	Kg

Volume	**Component A (resin)**	**18.02**	**Litres**
	Component B (hardener)	**6.79**	**Litres**

Weight	**Component A (resin)**	**22.17**	**Kg**
	Component B (hardener)	**6.65**	**Kg**

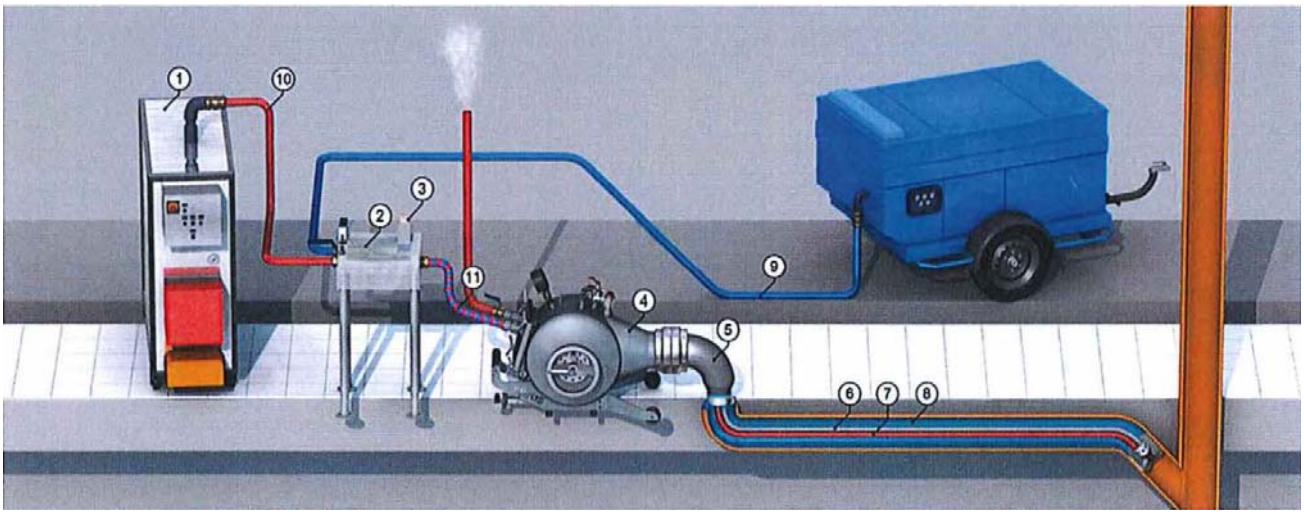
IMPORTANT
Please refer to the data sheet of both the liner and the resin system actually used

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 7**
Calculation of resin usage amounts epros®EPROPOX HC 120+	

VARIANT 1: Steam Cure with Heating Hose

System Layout

Item	Description
1	epros®SteamGen steam generator
2	epros®SteamTelemetry unit / epros®SteamMixingLance rig
3	epros®Temperature Data Logger
4	epros®Inversion Drum
5	epros®Inversion Fitting/Bend and steam-resistant inversion tube
6	epros®Inversion control tape
7	epros®SteamCirculation hose
8	epros®DrainFlexLiner / epros®DrainSteamLiner / epros®DrainPlusLiner
9	Air supply
10	Steam line
11	Steam/air feed line

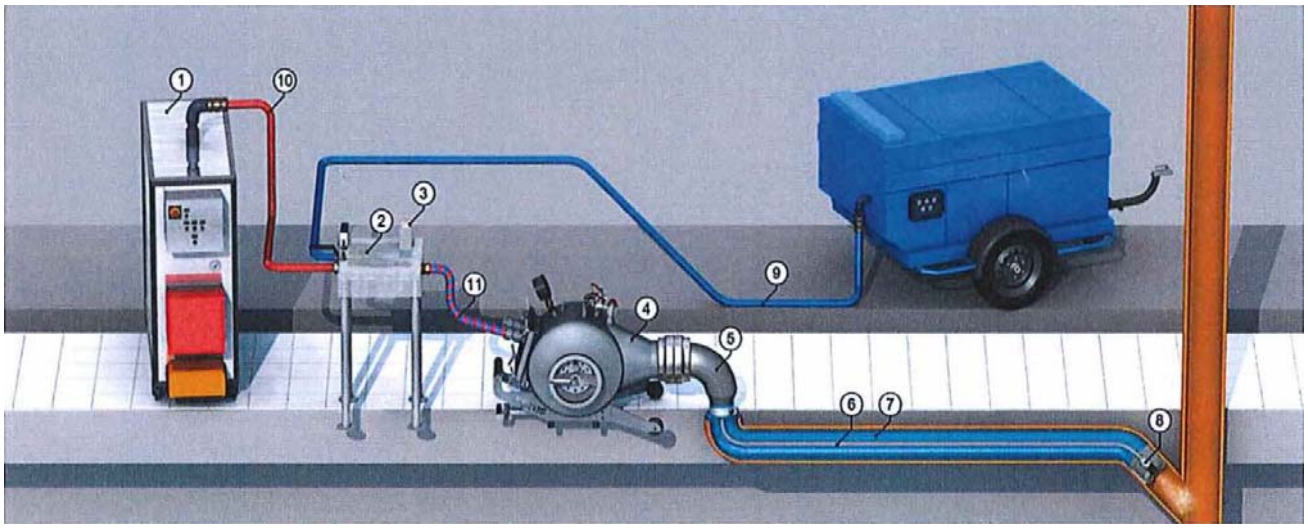


"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 8**
Variant 1 Steam cure with heating hose	

VARIANT 2: Steam Cure with Steam Outlet Valve

System Layout

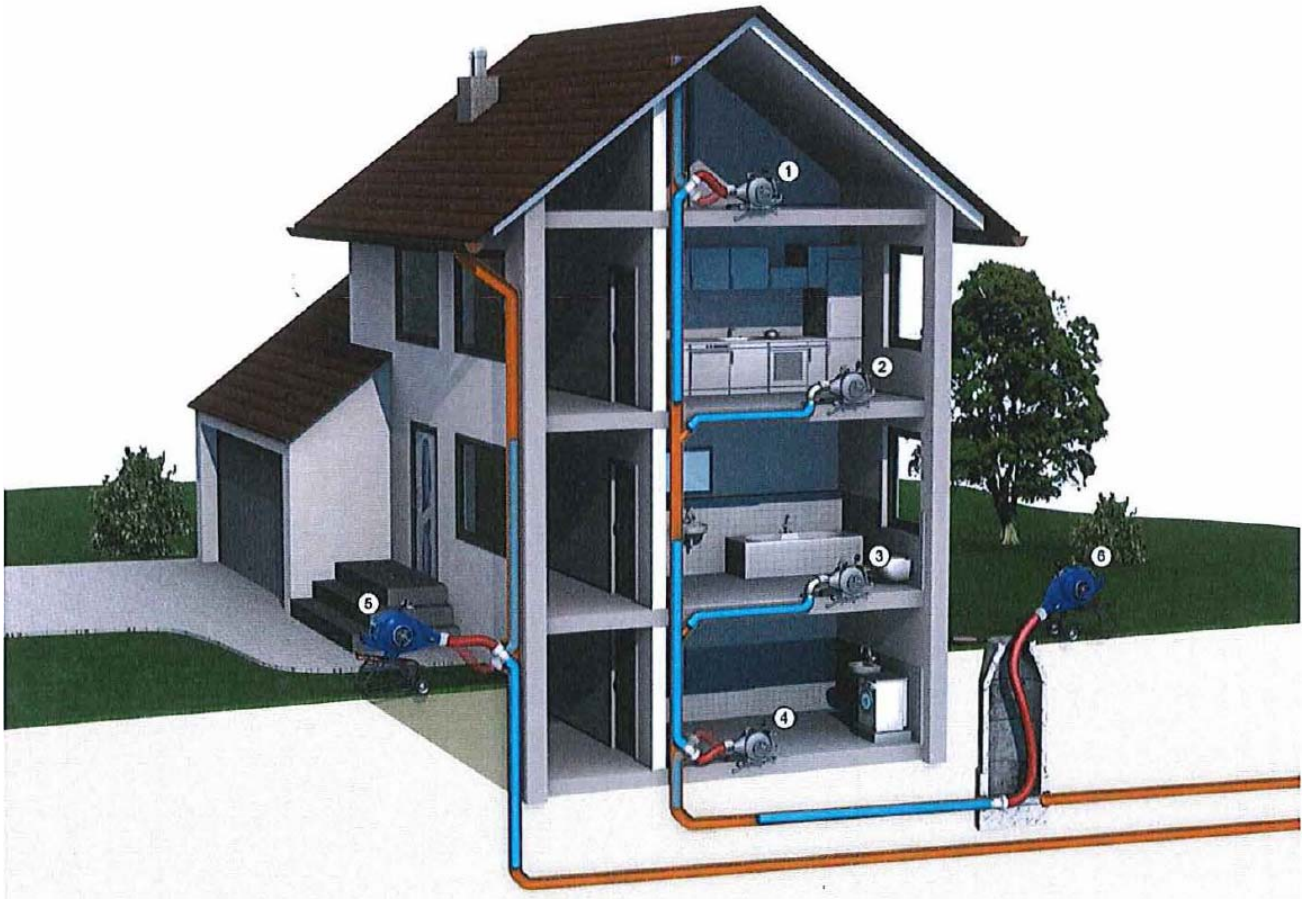
Item	Description
1	epros®SteamGen steam generator
2	epros®SteamTelemetry unit / epros®SteamMixingLance rig
3	epros®Temperature Data Logger
4	epros®InversionDrum
5	epros®Inversion Fitting/Bend and steam-resistant inversion hose
6	epros®Inversion control tape
7	epros®DrainFlexLiner / epros®DrainSteamLiner / epros®DrainPlusLiner
8	epros®SteamOutlet valve
9	Air supply
10	Steam line
11	Steam/air feed line



"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 9**
Variant 1 Steam cure with steam outlet valve	

"Residential Building" Application System Layout

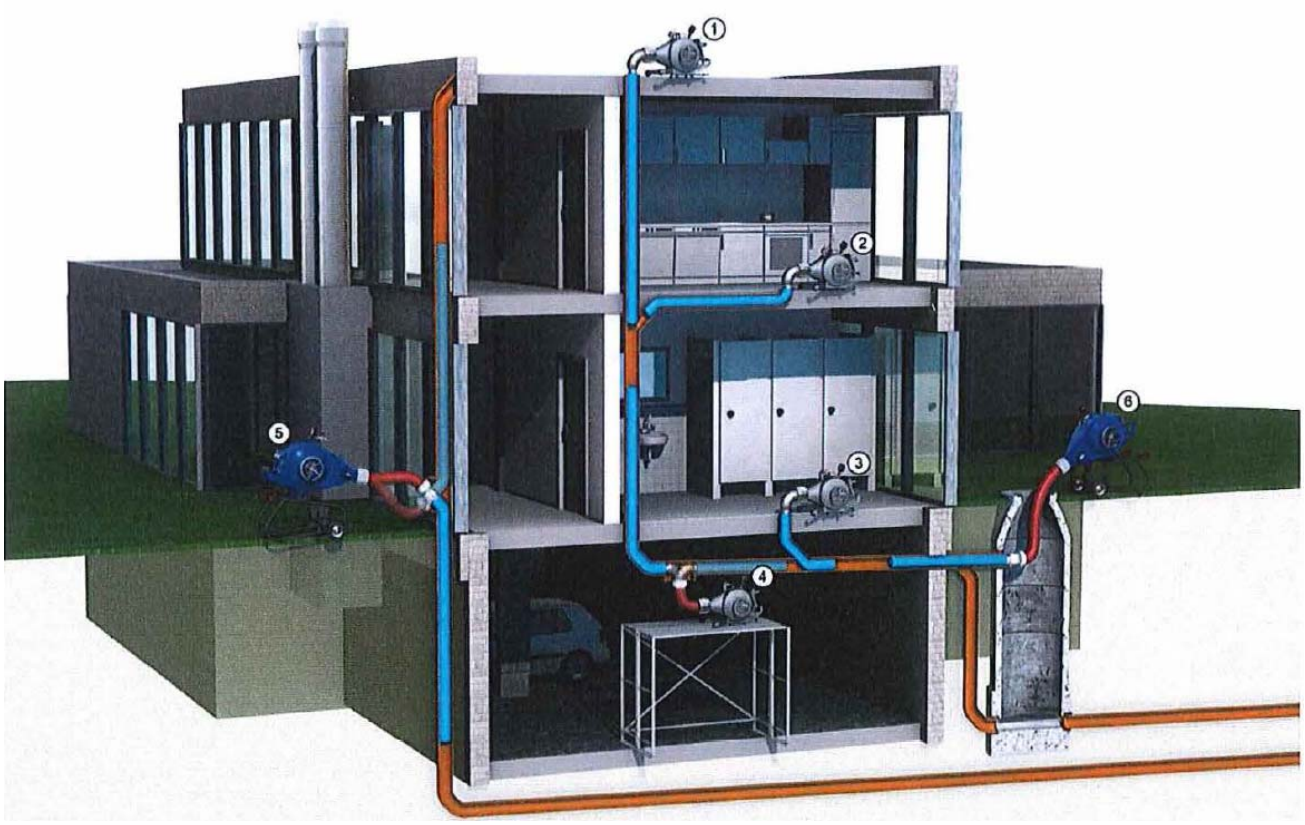
Item	Description
1	Installation through the inspection hole into the downpipe
2	Installation into a lateral pipe down to the downpipe
3	Installation into a lateral pipe down to the downpipe
4	Installation through the inspection hole into the downpipe or into the building sewer
5	Installation through the inspection hole into the rainwater downpipe or down into the building sewer
6	Installation through the building sewer into the downpipe



"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 10**
"Residential" application system layout for installation inside buildings	

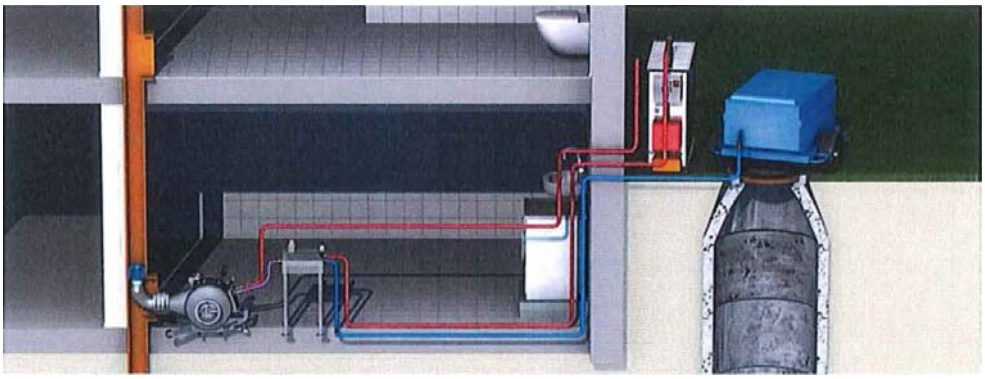
"Industrial Building" Application System Layout

Item	Description
1	Installation through the vent down into the downpipe
2	Installation into a lateral pipe down to the downpipe
3	Installation into a lateral pipe down to the downpipe
4	Installation through the inspection hole into the downpipe, building sewer or building drain
5	Installation through the inspection hole into the rainwater downpipe or down into the building sewer
6	Installation through the building sewer into the building drain or downpipe

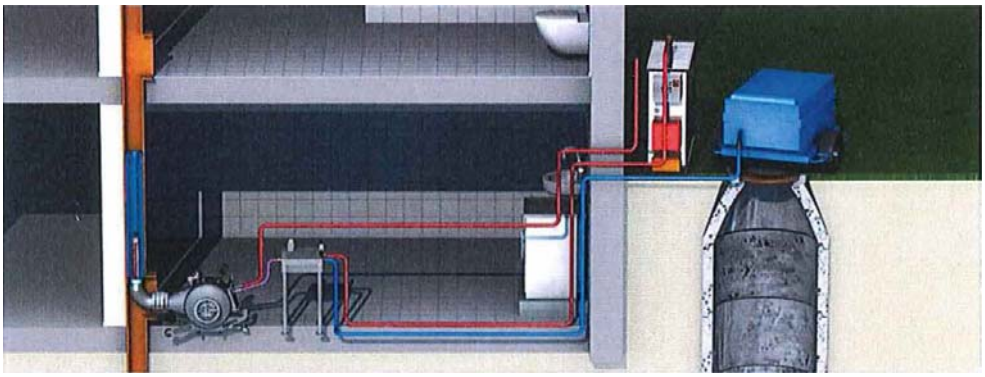


"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 11**
"Industrial" application system layout for installation inside buildings	

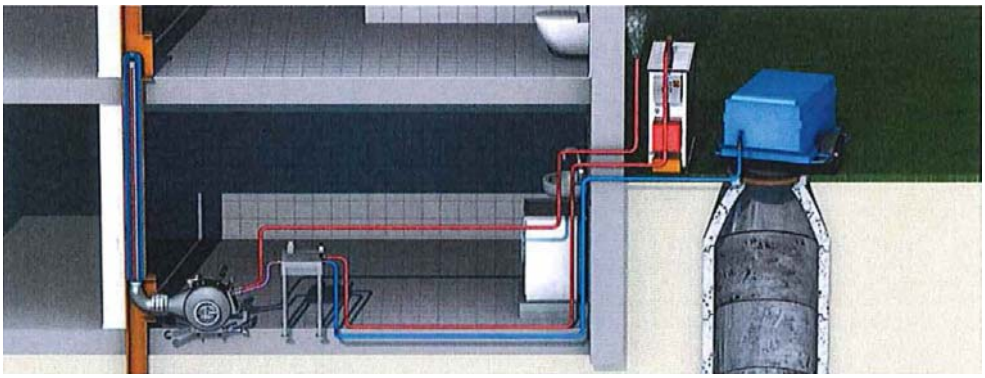
Steam Cure with Heating Hose
Closed-end method



1. Position the liner tube at the starting point; fix the control tape and the heating hose



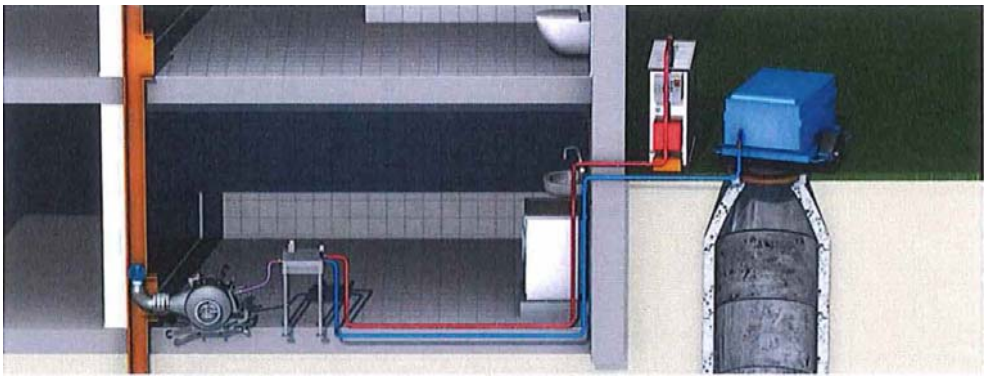
2. Invert the liner tube together with the heating hose



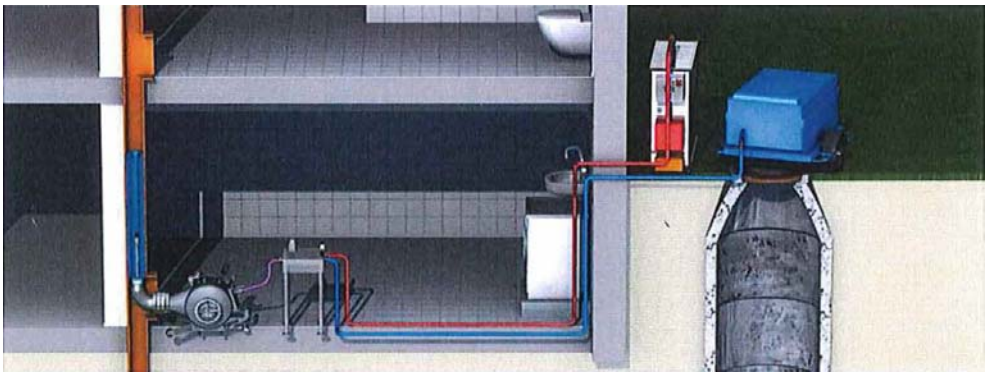
3. Steam cure: The fluid flows to the end of the liner tube and returns within the liner. The flow is controlled at the exit of the inversion drum

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 12**
Steam cure with heating hose and closed liner end Closed-end method	

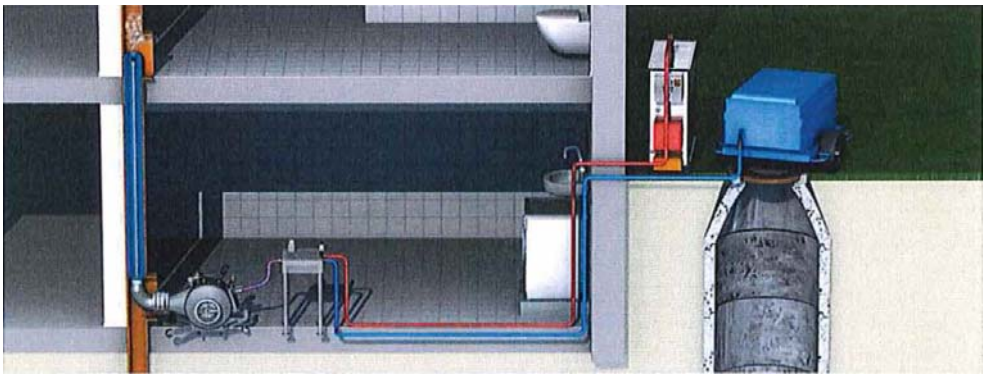
Steam Cure with Steam Outlet Valve
Closed-end method



1. Position the liner tube at the starting point; fix the control tape and the steam outlet valve.



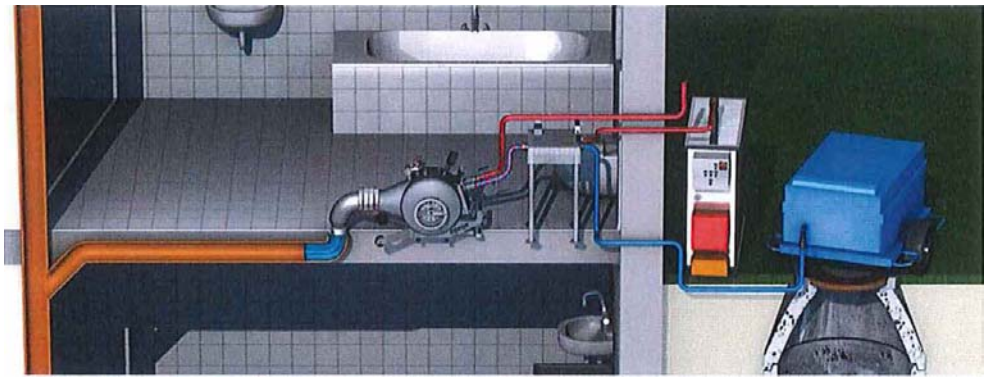
2. Invert the liner tube.



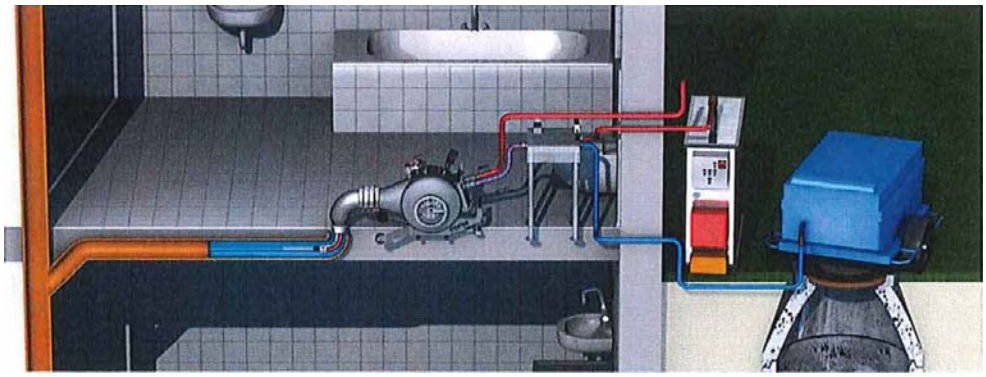
3. Steam cure: The fluid is passed to the tail end of the liner tube and flows out of the head of the liner through the steam outlet valve in the sense of inversion.

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 13**
Steam cure with steam outlet valve and closed liner end Closed-end method	

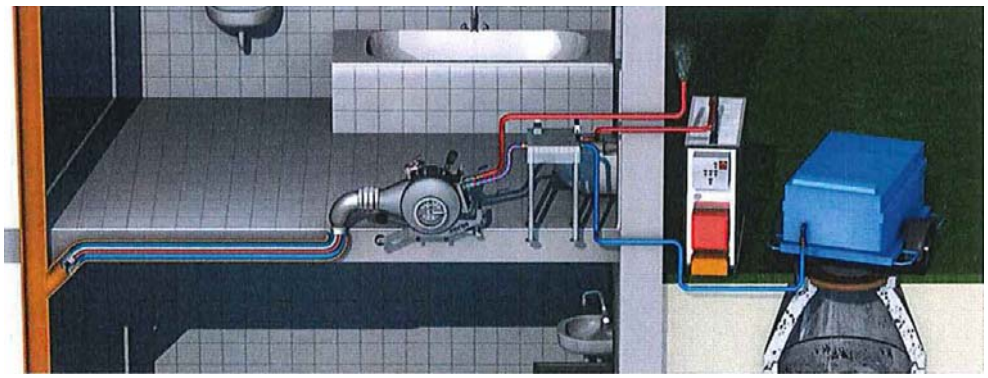
Steam Cure with Heating Hose and epros®LinerEndCap Open-end method



1. Position the liner tube at the starting point; fix the control tape and the heating hose to the LinerEndCap



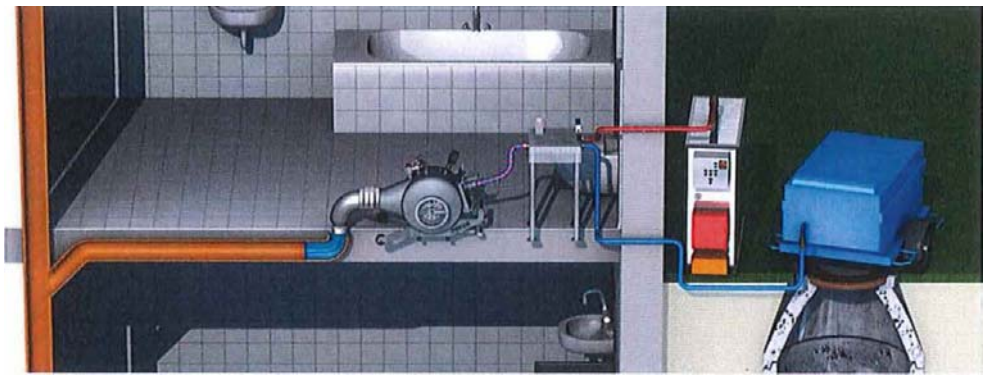
2. Invert the liner tube together with the heating hose.



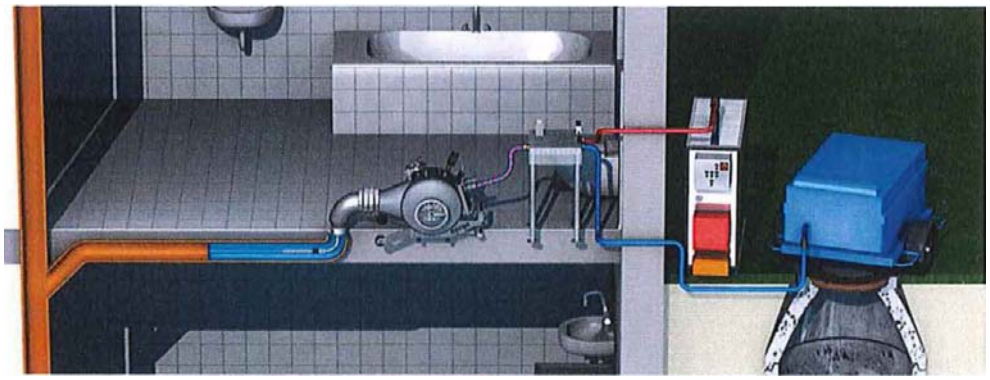
3. Steam cure: The fluid is passed to the end of the liner tube and returns within the liner. The flow is controlled at the exit of the inversion drum. After final cure, the LinerEndCap is removed and pulled back with the help of the control tape.

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 14**
Steam cure with heating hose, LinerEndCap and open liner end Open-end method	

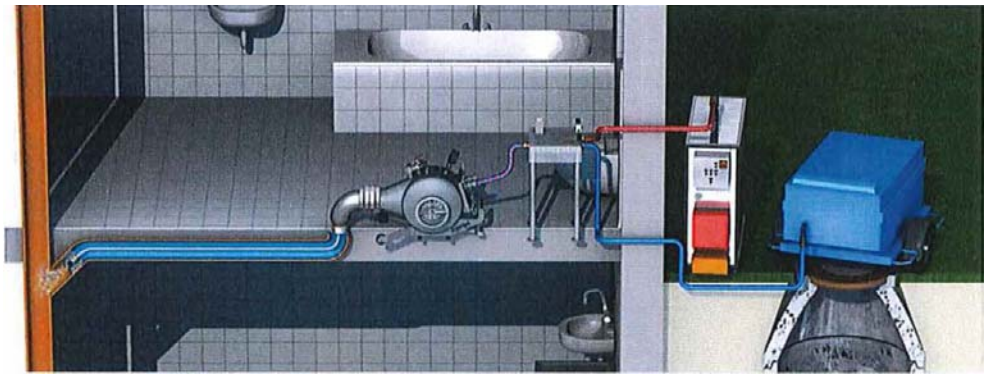
Steam Cure with Steam Outlet Valve and epros®LinerEndCap Open-end method



1. Position the liner tube at the starting point; fix the control tape to the steam outlet valve.



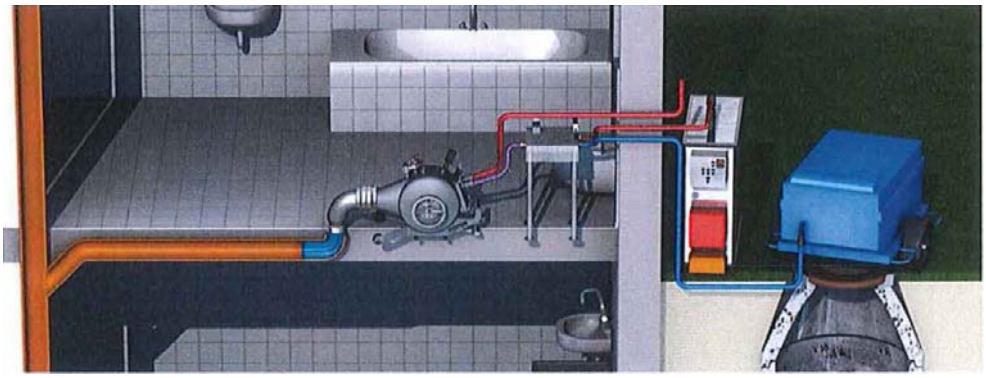
2. Invert the liner tube.



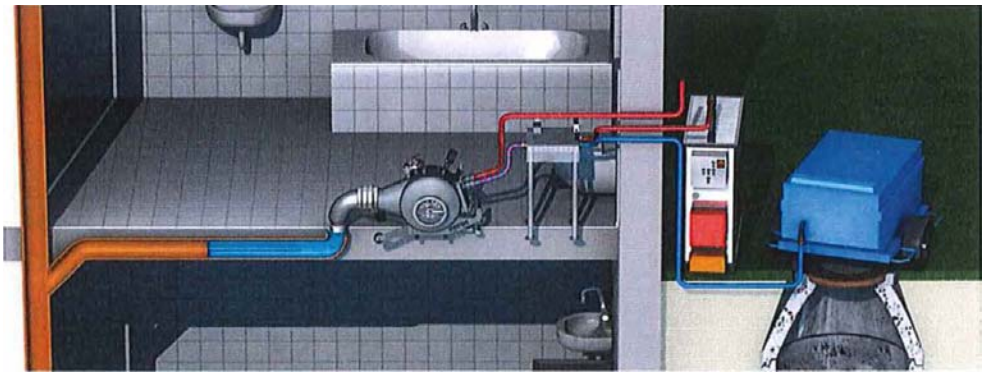
3. Steam cure: The fluid is passed to the end of the liner tube and released from the liner in the sense of inversion through the steam outlet valve. After final cure, the LinerEndCap is removed and pulled back with the help of the control tape.

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 15**
Steam cure with steam outlet valve, LinerEndCap and open liner end Open-end method	

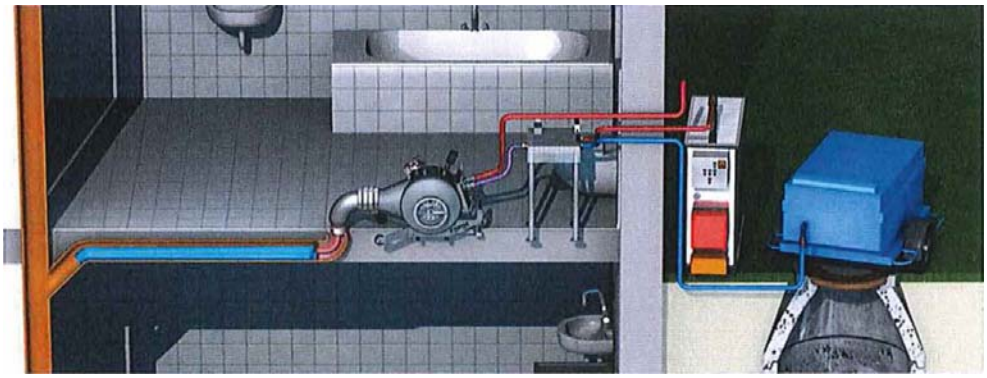
Steam Cure with Heating Hose and Calibration Hose 1 of 2
Open-End Method, calibration hose in a second step



1. Position the liner tube at the starting point.



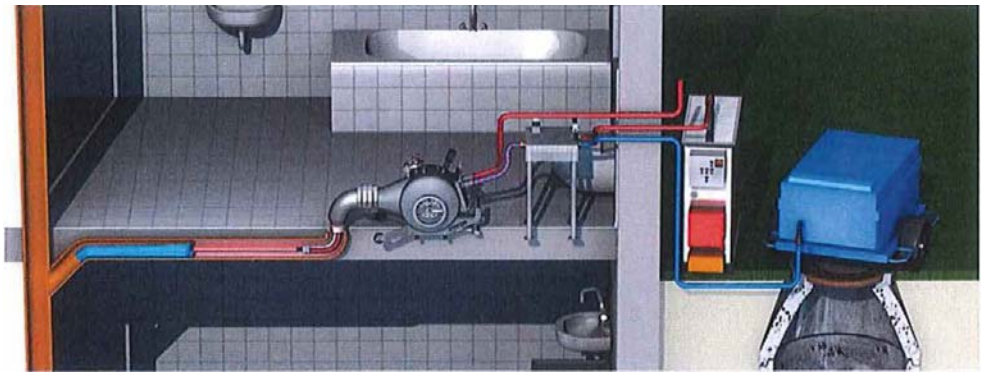
2. Invert the liner tube with open end.



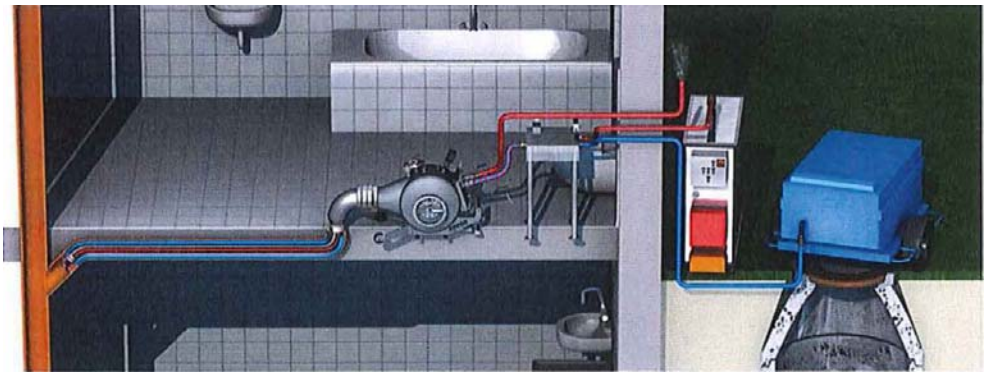
3. Disconnect the liner tube from the inversion fitting, insert the calibration hose und position it at the starting point.

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 16**
Steam cure with heating hose, calibration hose inverted in a second step Open-end method Page 1 of 2	

Steam Cure with Heating Hose and Calibration Hose 2 of 2
Open-End Method, calibration hose in a second step



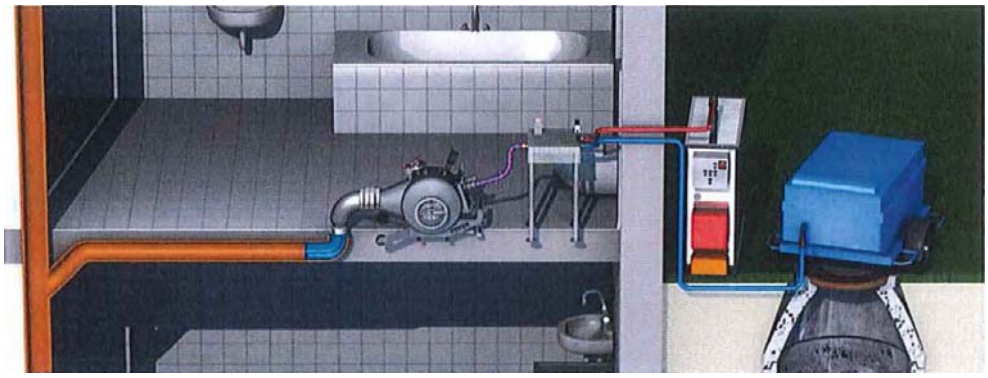
4. Invert the calibration hose into the liner tube. For curing, also invert the heating hose. Attach the control tape and the heating hose to the head of the calibration hose.



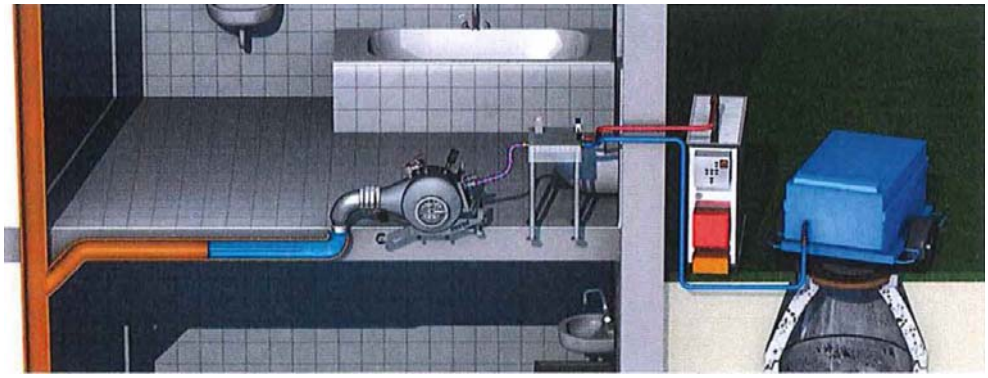
5. Cure with calibration hose: The fluid is passed through the heating hose to the end of the calibration hose and returns inside the liner. The flow is controlled at the exit of the inversion drum.

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 17**
Steam cure with heating hose, calibration hose inverted in a second step Open-end method Page 2 of 2	

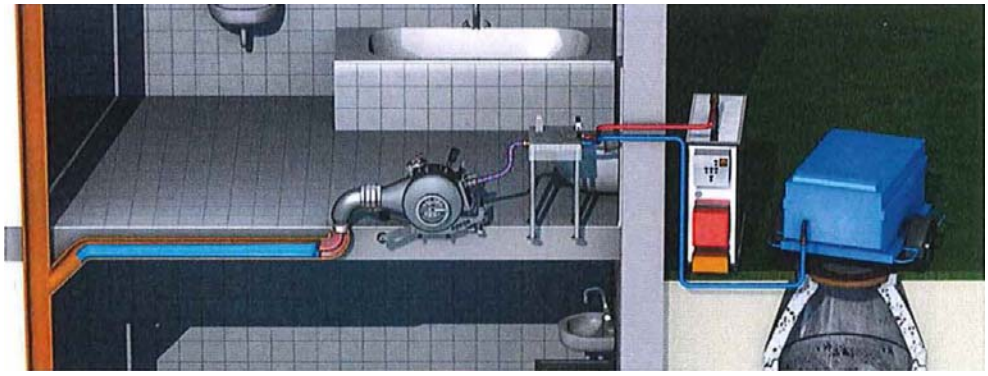
Steam Cure with Steam Outlet Valve and Calibration Hose 1 of 2
Open-end method, calibration hose in a second step



1. Position the liner tube at the starting point.



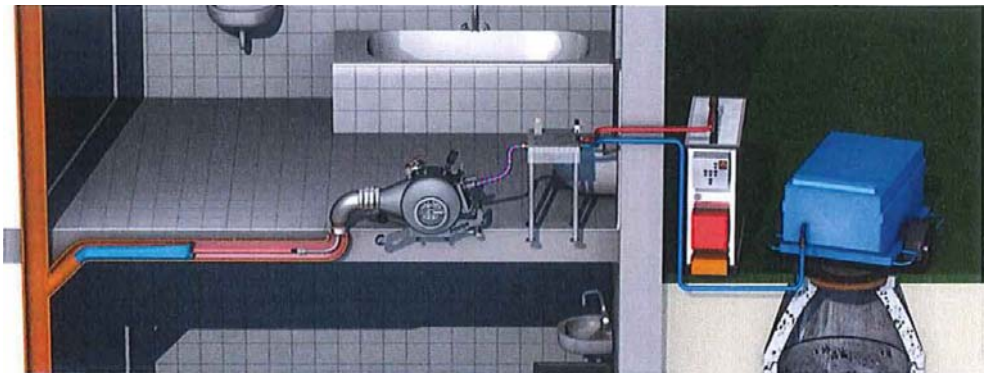
2. Invert the liner tube with open end.



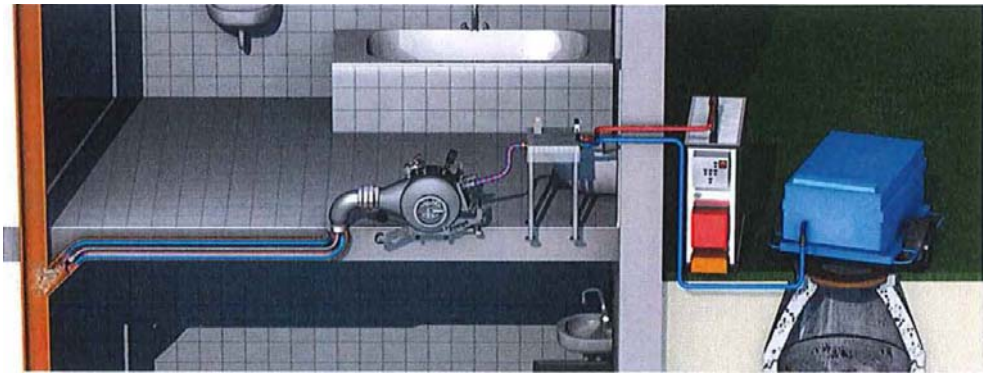
3. Disconnect the liner tube from the inversion fitting, insert the calibration hose und position it at the starting point.

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 18**
Steam cure with steam outlet valve, calibration hose inverted in a second step, Open-end method Page 1 of 2	

Steam Cure with Steam Outlet Valve and Calibration Hose 2 of 2
Open-end method, calibration hose in a second step



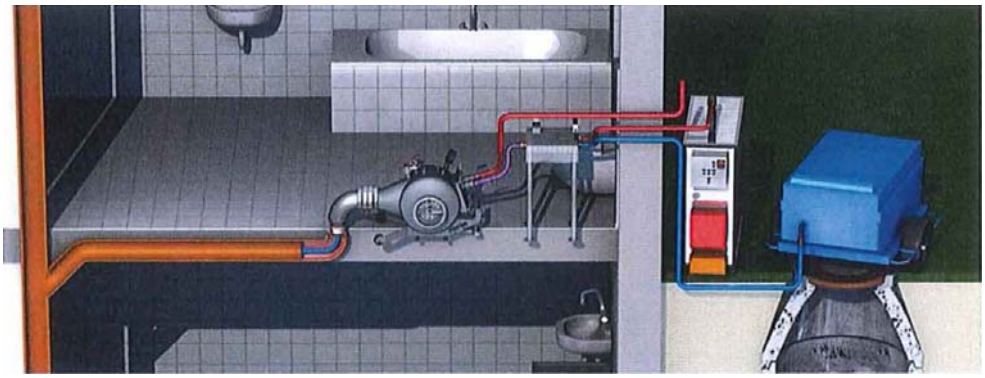
4. Invert the calibration hose into the liner tube. Attach the steam outlet valve to the calibration hose and connect the control tape to the steam outlet valve.



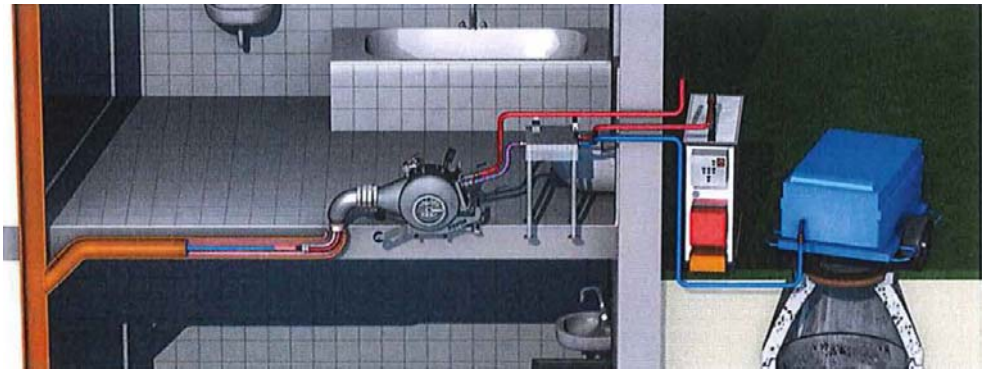
5. Cure with calibration hose: The fluid is passed to the end of the calibration hose and is released in the sense of inversion through the steam outlet valve.

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 19**
Steam cure with steam outlet valve, calibration hose inverted in a second step, Open-end method Page 2 of 2	

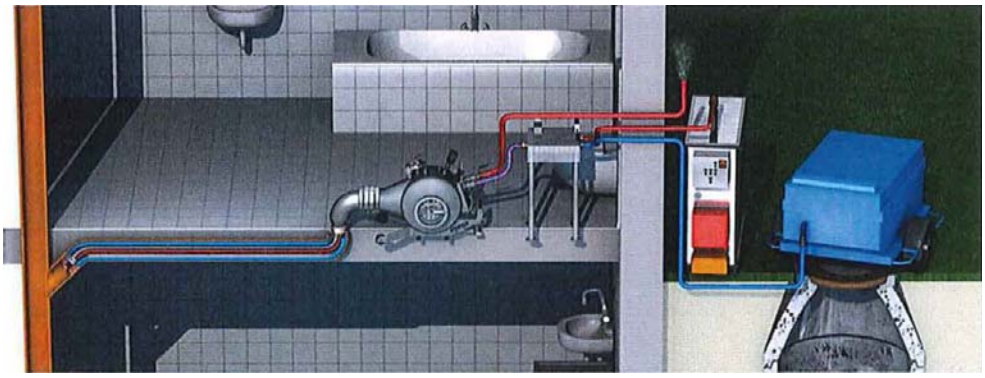
Steam Cure with Heating Hose and Calibration Hose
Open-end method, simultaneous inversion of calibration hose



1. Position the liner tube with the calibration hose at the starting point.



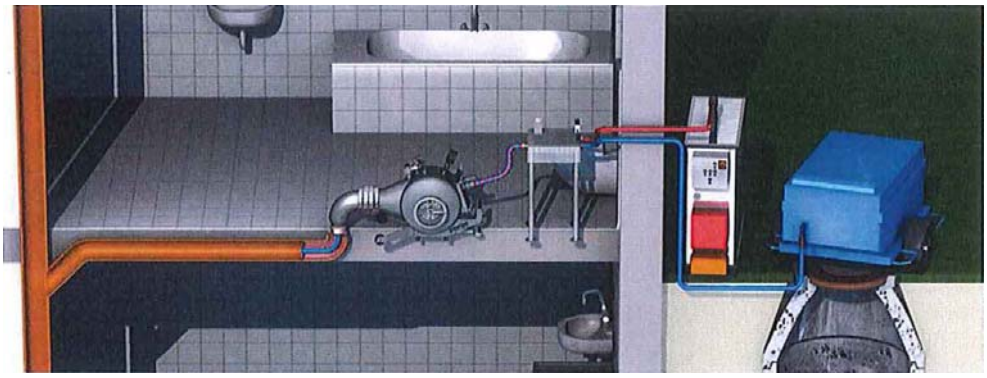
2. Invert the liner tube along with the calibration hose.



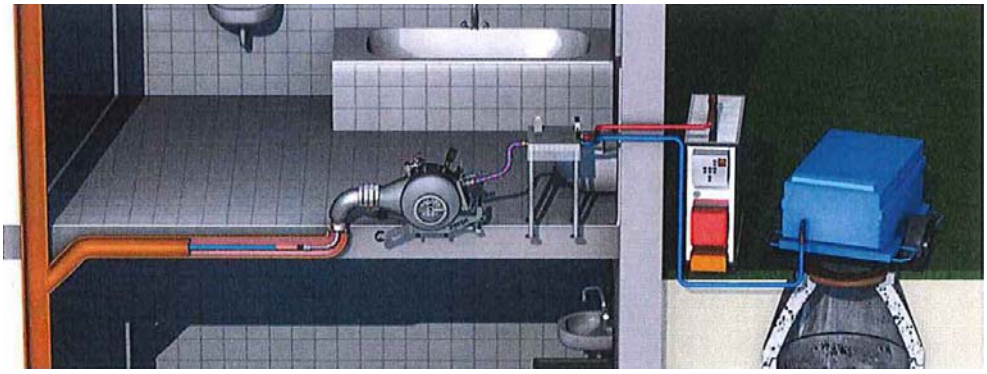
3. Cure with calibration hose: The fluid is passed to the end of the calibration hose via the heating hose and returns inside the liner. The flow is controlled at the exit of the inversion drum.

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 20**
Steam cure with heating hose, simultaneous inversion of calibration hose Open-end method	

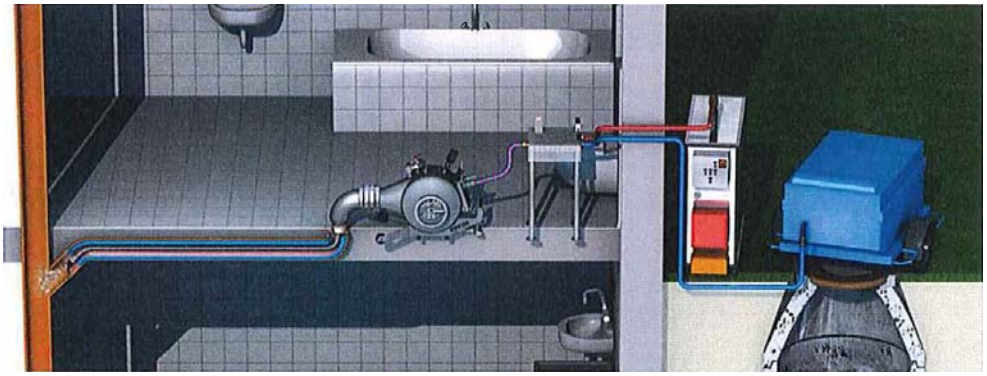
Steam Cure with Steam Outlet Valve and Calibration Hose
Open-end method, simultaneous inversion of calibration hose



1. Position the liner tube with the calibration hose at the starting point.



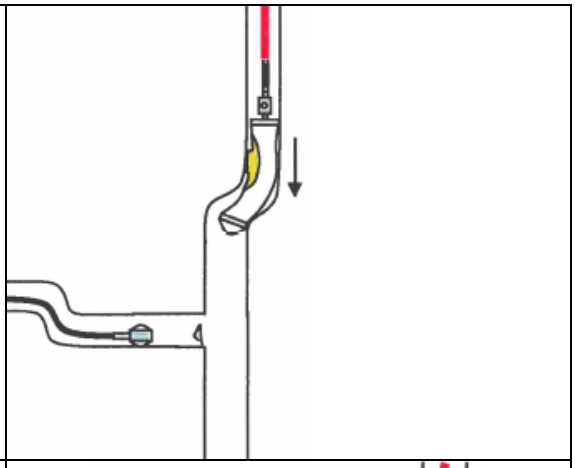
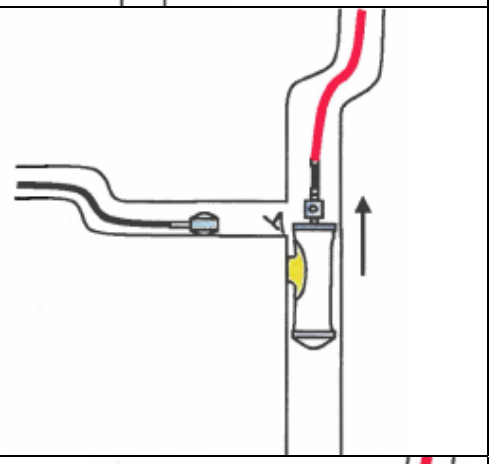
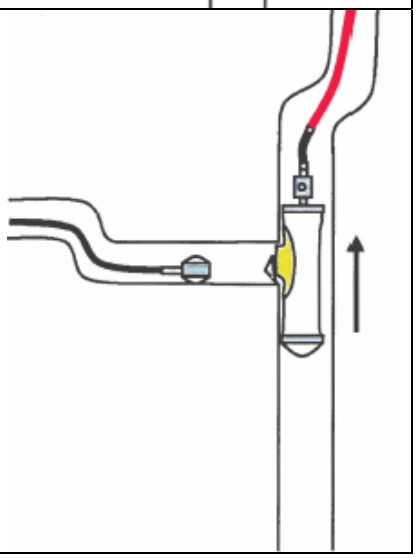
2. Invert the liner tube along with the calibration hose.



3. Cure with calibration hose: The fluid is passed to the end of the calibration hose and is released in the sense of inversion through the steam outlet valve.

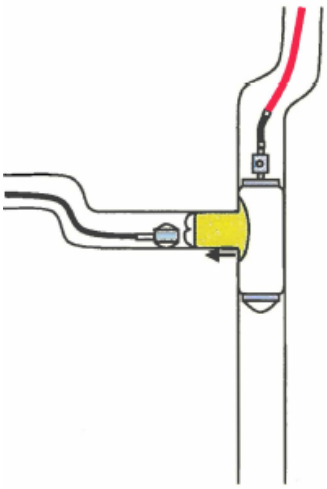
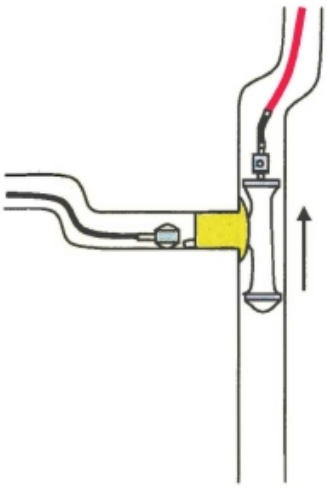
"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 21**
Steam cure with steam outlet valve, simultaneous inversion of calibration hose Open-end method	

epros®DrainLCR-B System using the "epros®DrainLCR B or S hat profile" Installation Process 1 of 2

Push LCR-B packer into the downpipe: The flexible LCR-B packer can be pushed through 45-degree bends down to the point of repair. A camera is placed in the lateral connection pipe to aid the positioning process.	
Position the LCR-B packer: The best way for easier positioning is to push the LCR-B packer beyond the lateral junction while making an attempt to properly align the LCR-B hat profile with the lateral.	
Final positioning of the LCR-B packer: The LCR-B packer is pulled back upwards and turned until the mouth of the LCR-B hat profile engages with the lateral opening in a properly centred position.	

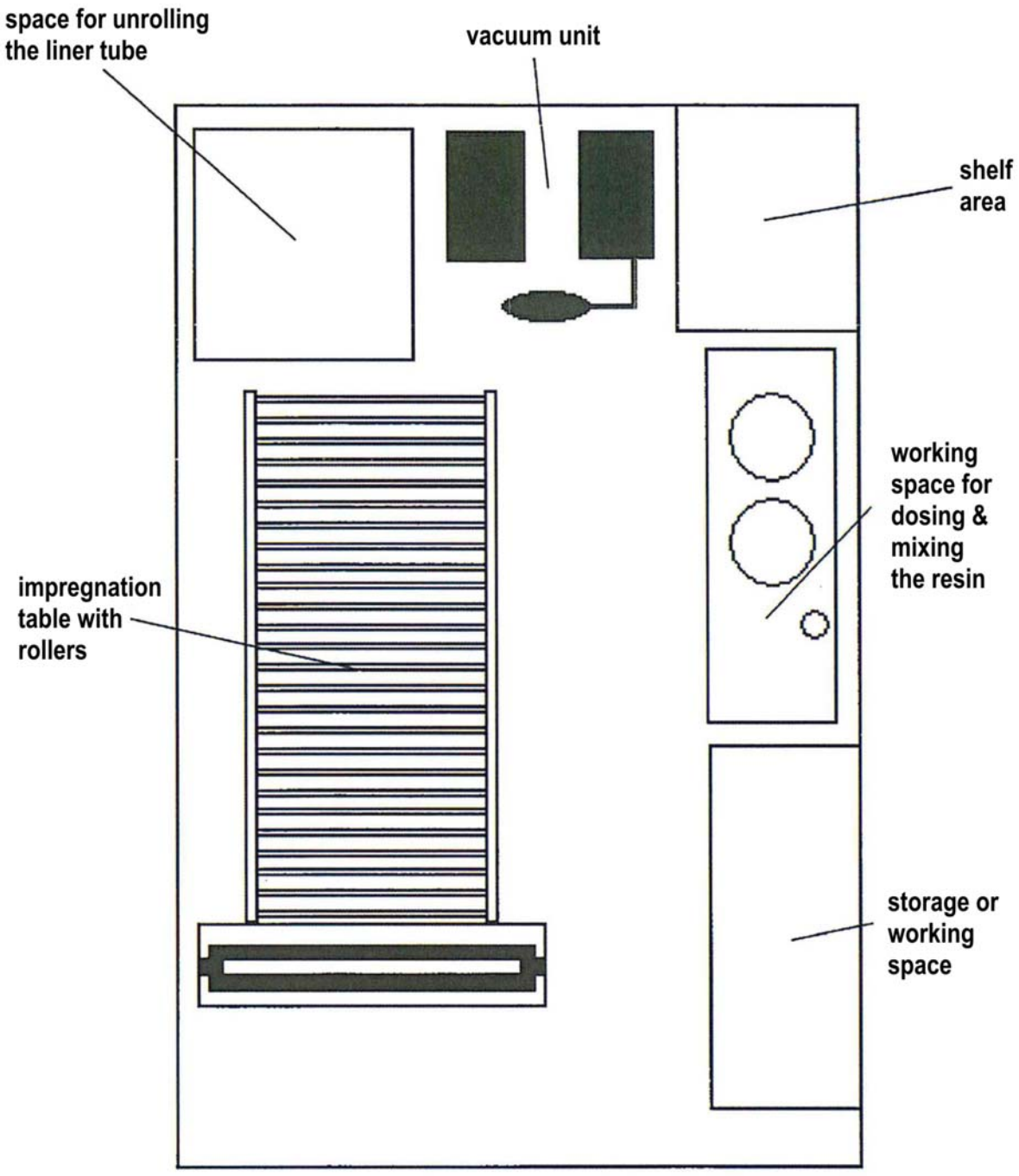
"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 22**
epros®DrainLCR-B Installation process page 1 of 2	

epros®DrainLCR-B System using the "epros®DrainLCR B or S hat profile" Installation Process 2 of 2

Installation of the LCR-B hat profile The inversion process is started, observed with the help of the camera in the lateral pipe. The inversion process is complete as soon as the LCR-B hat profile has been inverted entirely. The LCR-B control box shall be set to the desired curing pressure. Steam cure Steam shall be added slowly and continuously to the air cure pressure by means of the steam pressure regulating valve of the epros®SteamGen V3 or V6 steam generator until the temperature of max. 100°C is reached. Caution: Adding steam means to increase the pressure. Therefore, it is important to reduce the air pressure. Maintain the temperature during the whole curing time. At the end of the curing phase, fully close the steam pressure regulator valve and cool down the (lining) packer by means of pressurized air for some 15 minutes.	
Removal of the LCR-B packer: Remove the air from the LCR-B packer by means of the vacuum pump integrated in the LCR control box. So the deflated LCR-B packer can be separated entirely from the LCR-B hat profile and withdrawn from the line. After use, the packer must be cleaned and examined for damage.	

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 23**
epros®DrainLCR-B Installation process page 2 of 2	

Trailer configuration



"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"	**Appendix 24**
Proposal for truck or trailer configuration Trailer	

Inversion & Curing Pressures epros®DrainSteamLiner (PP)

Durchmesser Diameter		Wanddicke Wall thickness		*min.* Inversionsdruck Inversion pressure		*max.* Inversiondruck Inversion pressure		*min.* Aushärtedruck bei 10 °C Curing pressure at 50 °F		*min.* Aushärtedruck bei 80 °C Curing pressure at 176 °F		*max.* Aushärtedruck Curing pressure		Harzmenge Resin amount	
mm	inch	mm	inch	bar	psi	bar	psi	bar	psi	bar	psi	bar	psi	Liter/m	Gallon (US) / feet
100	4	3	0,12	0,4	5,8	1,4	20,3	0,63	9,1	0,42	6,1	0,7	10,2	1,1	0,09
100	4	4,5	0,18	0,6	8,7	2,1	30,5	0,95	13,7	0,63	9,1	1,05	15,2	1,6	0,13
125	5	3	0,12	0,4	5,8	1,4	20,3	0,63	9,1	0,42	6,1	0,7	10,2	1,4	0,11
125	5	4,5	0,18	0,6	8,7	2,1	30,5	0,95	13,7	0,63	9,1	1,05	15,2	2	0,16
150	6	3	0,12	0,4	5,8	1,4	20,3	0,63	9,1	0,42	6,1	0,7	10,2	1,6	0,13
150	6	4,5	0,18	0,6	8,7	2,1	30,5	0,95	13,7	0,63	9,1	1,05	15,2	2,3	0,19
150	6	6	0,24	0,8	11,6	2,8	40,6	1,26	18,3	0,84	12,2	1,4	20,3	3,1	0,25
200	8	3	0,12	0,3	4,4	1,1	16,0	0,50	7,2	0,33	4,8	0,55	8,0	2,1	0,17
200	8	4,5	0,18	0,5	7,3	1,6	23,2	0,72	10,4	0,48	7,0	0,8	11,6	3,1	0,25
200	8	6	0,24	0,6	8,7	2,1	30,5	0,95	13,7	0,63	9,1	1,05	15,2	4,1	0,33

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"

epros®DrainSteamLiner (PP)
Installation pressures

Appendix 25

Inversion & Curing Pressures epros®DrainFlexLiner

Diameter		Wall thickness		Min. inversion pressure		Max. Inversion pressure		Min. curing pressure at 50°F		Min. curing pressure at 176°F		Resin amount	
Durchmesser		Wanddicke		min. Inversionsdruck		max. Inversiondruck		min. Aushärtedruck bei 10 °C		min. Aushärtedruck bei 80 °C		max. Aushärtedruck	
mm	Inch	mm	Inch	bar	psi	bar	psi	bar	psi	bar	psi	bar	psi
100	4	3	0,12	0,34	4,9	0,99	14,4	0,40	5,8	0,31	4,5	0,43	6,2
100	4	4,5	0,18	0,51	7,4	1,49	21,5	0,60	8,7	0,47	6,7	0,65	9,4
125	5	3	0,12	0,27	3,9	0,79	11,5	0,32	4,6	0,25	3,6	0,34	5,0
125	5	4,5	0,18	0,41	5,9	1,19	17,2	0,48	7,0	0,37	5,4	0,52	7,5
150	6	3	0,12	0,23	3,3	0,66	9,6	0,27	3,9	0,21	3,0	0,29	4,2
150	6	4,5	0,18	0,34	4,9	0,99	14,4	0,40	5,8	0,31	4,5	0,43	6,2
150	6	6	0,24	0,46	6,7	1,33	19,3	0,54	7,8	0,42	6,1	0,58	8,4
200	8	3	0,12	0,17	2,5	0,50	7,2	0,20	2,9	0,16	2,2	0,22	3,1
200	8	4,5	0,18	0,26	3,7	0,74	10,8	0,30	4,4	0,23	3,4	0,32	4,7
200	8	6	0,24	0,35	5,0	1,00	14,5	0,41	5,9	0,32	4,6	0,44	6,3

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"

epros®DrainFlexLiner
Installation pressures

Appendix 26

Guidance For Use: epros®DrainPlusLiner with 9% undersize

DrainPlusLiner/ pipe dimension		Unit	DN 50 in DN 50 pipe	DN 50 in DN 70 pipe	DN 70 in DN 70 pipe	DN 70 in DN100 pipe	DN100 in DN100 pipe	DN100 in DN125 pipe	DN100 in DN150 pipe	DN125 in DN125 pipe	DN125 in DN150 pipe	DN150 in DN150 pipe	DN150 in DN200 pipe	DN200 in DN200 pipe
Undersize		%	9	9	9	9	9	9	9	9	9	9	9	9
Extra length per metre for open-end process with calibration hose in second step		cm per m	-6	13	4	15	2	10	20	-5	9	0	15	-1
Cut length per lining metre		m	0.94	1.13	1.04	1.15	1.02	1.10	1.20	0.95	1.09	1.0	1.15	0.99
Contact pressure in conjunction with the orange epros calibration hose – in straight pipe run		bar	0.7	0.9	0.5	1.2	0.3	0.5	1.0	0.4	0.55	0.1	0.55	0.20
		kPa	70	90	50	120	30	50	100	40	55	10	55	20
		psi	10.2	19.2	7.3	17.4	4.4	7.3	14.5	5.8	8.0	1.5	8.0	2.9
Burst pressure		bar	1.2	1.2	1.3	1.3	1.3	1.2	1.3	0.9	0.9	0.8	0.8	0.8
		kPa	120	120	130	130	130	120	130	90	90	80	80	80
		bar	17.4	17.4	18.9	18.9	18.9	17.4	18.9	13.1	13.1	11.6	11.6	11.6

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"

epros®DrainPlusLiner PUR with 9% undersize
Guidance for use

Appendix 27

Guidance For Use: epros®DrainPlusLiner with 18% undersize

Liner / pipe dimension	Unit	DN 50 in DN 50 pipe	DN 50 in DN 70 pipe	DN 70 in DN 70 pipe	DN 70 in DN100 pipe	DN100 in DN100 pipe	DN100 in DN125 pipe	DN125 in DN125 pipe	DN125 in DN150 pipe	DN150 in DN150 pipe	DN150 in DN200 pipe	DN200 in DN200 pipe
Undersize	%	18	18	18	18	18	18	18	18	18	18	18
Extra length per metre for open-end process with use of calibration hose in a second step	cm per m	-5	15	3	Not possible – Use liner with 9 % undersize.	5.5	12	0	12	5	12	2
Cut length per lining metre	m	0.95	1.15	1.03		1.055	1.12	1.0	1.12	1.05	1.12	1.02
Contact pressure in conjunction with the orange epros calibration hose – in straight pipe run	bar	1.1	1.2	0.8		0.3	0.6	0.3	0.5	0.3	0.6	0.3
	kPa	110	120	80		30	60	30	50	30	60	30
	psi	16.0	17.4	11.6		4.4	8.7	4.4	7.3	4.4	8.7	4.4
Burst pressure	bar	1.3	1.3	1.3		1.4	1.4	1.3	1.3	1.0	1.0	0.7
		130	130	130		140	140	130	130	100	100	70
	bar	18.9	18.9	18.9		20.3	20.3	18.9	18.9	14.5	14.5	10.2

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"

epros®DrainPlusLiner PUR 18% undersize
Guidance for use

Appendix 28

Guidance For Use: epros®DrainPlusLiner 1.0/2.0 with 10% undersize

epros®DrainPlusLiner 1.0 DN in mm – installed in host pipe DN in mm															
Final wall thicknesses		≥ 3 mm on DN basis, in expansion: ≥ 2.5 mm													
Resin amount calculated for		3.5 mm													
Roller (nip) distance		9 mm													
Liner size (mm)		50		70		100			125		150		200		
Pipe diameter (mm)		50	70	70	100	100	125	150	125	150	150	200	200	225	250
Extra length per metre	cm / m	-2	1	-2	1	-2	1	2	-2	1	-2	1	-2	1	2
Cut length per lining metre	m	0.7	0.7	0.98	1.01	0.98	1.01	1.02	0.98	1.01	0.98	1.01	0.98	1.01	1.02
Inversion pressure in straight pipe run	bar	0.3	0.4	0.4	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Curing pressure	bar	0.2	0.4	0.3	0.5	0.2	0.3	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.3
Burst pressure	bar	0.8	0.8	1.1	1.1	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.6	0.6	0.6

epros®DrainPlusLiner 2.0 DN in mm – installed in host pipe DN in mm												
Final wall thicknesses		≥ 4 mm on DN basis, in expansion: ≥ 3 mm										
Resin amount calculated for		4.5 mm										
Roller (nip) distance		11 mm										
Liner size (mm)		70		100			125		150		200	
Pipe diameter (mm)		70	100	100	125	150	125	150	150	200	200	225	250
Extra length per metre	cm / m	-2	1	-2	1	2	-2	1	-2	1	-2	1	2
Cut length per lining metre	m	0.98	1.01	0.98	1.01	1.02	0.98	1.01	0.98	1.01	0.98	1.01	1.02
Inversion pressure in straight pipe run	bar	0.5	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.25	0.3	0.25	0.2
Curing pressure	bar	0.4	0.6	0.3	0.35	0.4	0.3	0.35	0.2	0.3	0.25	0.3	0.35
Burst pressure	bar	1.4	1.4	1	1	1	0.9	0.9	0.8	0.8	0.7	0.7	0.7

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"

epros®DrainPlusLiner TPU
10% undersize

Appendix 29

Site Visit Form

epros®DrainLiner Method -- Rehabilitation of Pipes Within Buildings
Site Visit Report

Individual report per lining operation: ☐ Sanitary ☐ Storm water — Project No. — Initial CCTV survey ☐ existing ☐ inexisting — Survey dated:

Job site: — Name:

Street address: — Name:

	From access point no. (A)	To access point no. (B)	Location of access point (A)	Location of access point (B)	DN size **verified** (mm)	DN acc. to **layout plan** (mm)	Length (m)	Damage type/pattern
1								
2								
3								
4								
5								
6								
7								

Comments:

Distance from lining location

Water connection	m	
Pit hydrant	m	
Hose bridges	No ☐	
	Yes ☐	
Road width	m	
Accessibility with motor vehicle	Good access ☐	
	No access ☐	
	Distance (m)	
Traffic load	Private property ☐	
	Side street ☐	
	Main street ☐	
Traffic control required:	Yes ☐	
	No ☐	
Service flow management	Yes ☐	
	No ☐	
Type of flow management:	Retention ☐	
	Overpump ☐	

Inspection holes available Yes ☐ No ☐

Comments regarding the survey:

1
2
3
4
5
6
7

Sketch if required:

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"

Appendix 30

Site Visit Form

Liner Fabrication Report Form

epros®DrainLiner method for the rehabilitation of damaged pipes
Liner Fabrication Report

Project Data

Lining vehicle:		Date:		Site No.:	
Project:					
Street address:		ZIP code:		Town/city:	
Client:					
Job No.:		From point:		To point:	
Shape:		DN:	mm	Liner length	
				Target wall thickness	

Material / Material Consumption

Carrier material

epros®DrainFlexLiner (PP)		Batch No./wall thickness	/	mm
epros®DrainLiner (PP)		Batch No./wall thickness	/	mm
epros®DrainSteamLiner (PP)		Batch No./wall thickness	/	mm
epros®DrainPlusLiner (PUR)		Batch No./wall thickness	/	mm
epros®DrainPlusLiner 1.0 (SK)		Batch No./wall thickness	/	mm
epros®DrainPlusLiner 2.0 (SK)		Batch No./wall thickness	/	mm

Resin system name / type:

Basic Data

Resin data	Target*	Actual
Storage temperature	see data sheet	°C
Resin : hardener mixing ratio (kg)	: (acc. to TDS)	:
Mixing temperature	> 10°	
Pot time at 25°C in min.	(acc. to TDS)	
Usage amount of component A (kg)		
Usage amount of component B (kg)		
Total usage amount of components A + B		
Comp. A batch no.:		
Comp. B batch no.:		

Fabrication Conditions

		Target*	Actual
Impregnation	Vacuum	0.5 bar	
	Roll nip setting	2 x "s" + 2 mm	
Temperatures	Ambient (°C)		
	Resin (°C)		
	Hardener (°C)		
	Liner after impregnation (°C)		
Time / duration		Start (time)	End (time)
	Mixing target: 3 minutes		
	Impregnation		
	Inversion		
	Filling with water		

On-site retention samples
Carrier material / site description
Carrier material / site description

Remarks

Date Signature

* Target values must be taken from the Method Statement or Technical Data Sheets according to the resin system used.

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"

Liner Fabrication Report Form

Appendix 31

Cure Report Form

epros®DrainLiner method for rehabilitation of damaged pipes
Liner Cure Report

Date: _____

Project: _____

Client: _____

Pipe run: _____ **Operative:** _____

Plant: _____ **1st measurement at :** _____ (time)

Measuring points schedule

a	—	Air temperature	°C
b1	—	Heating flow temperature	°C
b2	—	Steam/air mixture	°C
c	—	Curing pressure	bar

		Meas.point 1	Meas.point 2	Meas.point 3	Time	°C	Remark
1	—						
2	—						
3	—						
4	—						
5	—						
6	—						
7	—						
8	—						
9	—						
10	—						
11	—						
12	—						
13	—						
14	—						
15	—						
16	—						
17	—						
18	—						
19	—						
20	—						

"CIPP liner known as "epros®DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"

DrainLiner Method
CIPP Liner Cure Report

Appendix 32

Liner Installation Report Form

epros® DrainLiner method for rehabilitation of damaged pipes
Liner Installation Report

Project Data

Lining vehicle: _____ Date: _____ Site No.: _____
Project _____
Street address _____ ZIP code: _____ Town/city: _____
Client _____

Job No. _____ From point: _____ To point: _____
Shape: _____ DN: _____ mm Liner length _____
Target wall thickness:

Job Preparation

Traffic control:	yes / no	Initial inspection:	yes / no
Security at work:	yes / no	Surface treatment:	yes / no
Sewer cleaned:	yes / no	Post-cleaning:	yes / no
Diameter checked:	yes / no	Service flow stopped:	yes / no

Installation conditions

Groundwater present:	yes / no	Calibration hose used:	yes / no
Preliner inverted:	yes / no		

Inversion Method:

Water column
Rig height + manhole: _____ metres
Water pressure: _____ bar

Inversion drum
Inversion pressure: _____ bar
Curing pressure: _____ bar

	Target pressure	min – max	acc.to TDS
Inversion pressure:		–	bar
Curing pressure:		–	bar

Downstream inversion ☐ closed end ☐
Upstream inversion ☐ open end ☐

Inversion Method:

Hot water:: ☐ Steam: ☐ Ambient: ☐

Amount of water required for hot cure: _____ m²

Curing from _____ (time) to _____ (time) Checked (name): _____
Cooling from _____ (time) to _____ (time) Checked (name): _____

Sample taken from manhole no. _____

Sampling position:
Wall segment: ☐
Supporting pipe: ☐

Documentation

Rework:	yes / no	Leakage test:	yes / no
Final CCTV inspection:	yes / no	Completion	yes / no

Remarks

Date _____ Signature _____

"CIPP liner known as "epros® DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"

DrainLiner Method
Liner Installation Report Form

Appendix 33

LCR System Installation & Fabrication Report Form 1 of 2

Report No.: _____

Trelleborg epros LCR liner ☐ **LCR-B hat profile** ☐

LCR-S hat profile ☐

Construction project: _____

Client/project owner:		Installer:	
Street address:		Street address:	
Town/city:		Town/city:	
Contact:		Contact:	

Persons in charge: _____

Pipe line data:

Maine line		**Lateral connection**	
Sewer type:		Sewer type:	
Line no.:		Connection no.:	
Access point (A):		Station:	m
Access point (B):		Position:	o' clock
Pipe type/material:		Diameter DN:	
Diameter DN:			

Job preparation:

Traffic safety/control:	yes – no	Initial CCTV:	yes – no
Work safety:	yes – no	Cutting:	yes – no
Pipe cleaned:	yes – no	Final cleaning:	yes – no
Diameter verified:	yes – no	Flow management:	yes – no

LCR System Installation & Fabrication Report Form 2 of 2

Installation conditions:

Liner tube material:

Supplier:		Designation:	
Temperature:		Length in lateral	cm
Batch:		Wall thickness:	mm

Resin:

Supplier:		Resin type:	
		Resin amount:	Litres

Mixing ratio (component A / component B by volume)

Component A:		Batch A:	Litres
Component B:		Batch B:	Litres

Installation:

Packer system:		Installation pressure:	bar
		Curing pressure:	bar
Outdoor temperature:		Temp. inside sewer:	°C
Pot time:	max. target:	Actual time:	min
Curing time:	min. target	Actual time:	min

Documentation:

Rework:	yes – no
CCTV final inspection (acceptance):	yes – no
Service flow re-established:	yes – no
Lining result achieved:	yes – no
Tightness test completed:	yes – no
Remarks:	

Date: **Signature:**

Sample Delivery Note

SAMPLE DELIVERY NOTE FOR TESTING OF LINER MATERIAL

☐ *INITIAL TEST* ☐ *REPEATED TEST* *for Test Report No.* ____

1. Sampling data:

Sample taken by:		Test institute:	
Date / time:		Address:	

2. Sample identification:

Project:			Material ID:			
Project owner / client:			Sample description:			
Cost centre:			Sewer line description:			
Installer firm:			Nominal diameter:			
Liner manufacturer:			Date installed:			
Carrier material:			Host pipe condition:	O I	O II	O III
Resin material:			Sampling location:	O MH-MH line	O final MH	O interm. MH
Pipe geometry:	O circular	O egg shape	Sampling position:	O crown	O springline	O invert

3. Required initial properties according to structural design calculations:

Flexural E-modulus$_{DIN}$ E_f [N/mm^2]:		Circumferential E-modulus E_U [N/mm^2]:	
Flexural stress$_{at\ first\ break}$ σ_{fB} [N/mm^2]:		Initial ring stiffness S_0 [N/m^2]:	
Wall thickness **d** [mm]:		Maximum creep K_{N24} [%]:	
Reduction factor A_1 :		Density δ [g/cm^3]:	

4. Test results:

Flexural modulus, bending stress acc. to DIN EN ISO 178 ☐

Date tested	E_f [N/mm^2]	σ_{fB} [N/mm^2]	h [mm]
	Load type	O axial	O radial

24 h creep after DIN EN ISO 899-2 ☐

Date tested	K_N [%]

Circumf. E-modulus, initial ring stiffness acc. to DIN EN 1228 ☐

Date tested	E_U [N/mm^2]	S_0 [N/m^2]	h [mm]

24 h creep after DIN EN 761 ☐

Date tested	K_N [%]

Water tightness acco. to DIN EN 1610 ☐

Date tested	Load period	Test pressure [bar]	Test result	
	30 minutes		O passed (tight)	O failed (leaking)

Calcination method acc. to DIN EN ISO 1172 ☐

Date tested	Resin [%]	Total residues [%]	Glass content [%]	Additive [%]

Spectral analysis after ASTM D 5576 (FT-IR) ☐

Date tested	EP resin	UP resin	VE resin	Other resin

Density acc. to DIN EN ISO 1181-1 or -2 ☐

Date tested	δ [g/cm^3]

Thermal analysis acc. to DIN EN ISO 11357-1 / DSC analysis DIN 53765 Method A ☐

Date tested	Glass transition temperature [°C]			Enthalpy [J/g]	
	T_{G1}		ΔT_G	O exothermic	O endothermic
	T_{G2}				

Residual styrene content acc. to DIN 53394-2 (GC) ☐

Date tested	Weighed-in quantity [mg]	Residual styrene [mg/kg]	Residual styrene [%]	Weight-in quantity referred to	
				O Total quantity	O Pure resin

5. Evaluation of results:

Requirement	met	not met	Requirement	met	not met
Flexural-E-modulus E_f	O	O	Circumfer. E-modulus E_U	O	O
Flexural stress σ_{fB}	O	O	Initial ring stiffness S_0	O	O
Wall thickness **d**	O	O	24 h creep K_N	O	O
Water tightness	O	O	Density δ	O	O

6. Remarks:

7. Signature of tester / laboratory:

"CIPP liner known as "epros® DrainLiner" for rehabilitation of defective sanitary pipes, rainwater downpipes and house drains inside the building structure in the nominal diameter range from DN 50 to DN 200"

Sample Delivery Note

Appendix 36