Deutsches Institut für Bautechnik

DIBt

Allgemeine bauaufsichtliche Zulassung

Zulassungsstelle für Bauprodukte und Bauarten

Bautechnisches Prüfamt

Eine vom Bund und den Ländern gemeinsam getragene Anstalt des öffentlichen Rechts

Mitglied der EOTA, der UEAtc und der WFTAO

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Z-42.3-414

Geltungsdauer
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bis: **30. Juli 2022**

Antragsteller:
I.S.T.
InnovativeSewerTechnologies GmbH
Rombacher Hütte 19
44795 Bochum

Subject of approval:
Pipe lining method with the name "EasyLiner" for the rehabilitation of underground sewage pipes in the nominal diameter range from DN 100 to DN 600

The above-mentioned object of approval is hereby generally approved by the building authorities.
This general building supervisory approval comprises 26 pages and 24 annexes.
This general building approval replaces the general building approval no. Z-42.3-414 of 27 October 2016.

I GENERAL PROVISIONS

1 With the general building inspection approval, the usability or applicability of the object of approval in terms of the state building regulations is proven.

2 The general building authority approval does not replace the approvals, consents and certificates required by law for the execution of building projects.

3 The general building inspection approval is granted without prejudice to the rights of third parties, in particular private property rights.

4 The manufacturer and distributor of the subject of the approval shall, without prejudice to further provisions in the "Special Provisions", provide the user or user of the subject of the approval with copies of the general building supervision approval and point out that the general building supervision approval must be available at the place of use. Copies of the general building supervision approval must be made available to the authorities involved on request.

5 The general technical approval may only be duplicated in full. Publication in extracts requires the consent of Deutsches Institut für Bautechnik. Texts and drawings of advertising material may not contradict the general building authority approval. Translations of the general technical approval must contain the note "Translation of the German original version not verified by Deutsches Institut für Bautechnik".

6 The general technical approval is revocable. The provisions of the general technical approval may be supplemented and amended subsequently, in particular if new technical findings make this necessary.

7 This decision relates to the data and documents submitted by the applicant in the authorization procedure on the subject of authorization. A change of these approval bases is not covered by this notification and must be disclosed to Deutsches Institut für Bautechnik without delay.

SPECIAL PROVISIONS

1 Subject matter and scope of approval

This general building authority approval applies to the hose lining method with the designation "EasyLiner" (Appendix 1) and the two-component epoxy resin systems with the designations "EasyPox 3008" and "EasyPox 6024" (cold-curing resin systems) and "EasyPox T0530" (thermosetting resin system) for the rehabilitation of damaged sewer pipes with circular cross-sections in the nominal widths DN 100 to DN 600. This approval applies to the rehabilitation of sewer pipes which are intended to drain off waste water in accordance with DIN 1986-31.

The pipe lining method can be used for the rehabilitation of sewer pipes made of concrete, reinforced concrete, stoneware, asbestos-free fiber cement, the plastics GRP, PVC-U, PE-HD and cast iron, provided that the cross-section of the sewer pipe to be rehabilitated meets the process-related requirements and the static requirements.

Damaged sewer pipes are rehabilitated by inserting and subsequent curing of an epoxy resin-impregnated, polyurethane-coated polyester fiber hose with the designations "ThermoLiner 3.5 mm and 5.0 mm", "ThermoLiner^{plus}" and "Thermo Liner M".

For this purpose, the polyester fiber hose, which is coated on the inside with polyurethane (PU), is impregnated with epoxy resin on site. The hose liner is inserted (inverted) into the pipe to be rehabilitated using compressed air or water. By inverting the hose liner, the polyurethane-coated side of the polyester fiber hose becomes the side facing the wastewater. The pressure applied causes a form-fit pressing against the inner wall of the existing pipe. The curing of the hose liner takes place by means of hot water circulation, steam or at ambient temperatures.

In groundwater-saturated zones, a polyethylene protective hose (PE-preliner) must be inserted before inverting the resin-impregnated, polyurethane-coated polyester fiber hose.

Lateral connections can be restored either in open construction or by means of renovation procedures, for which general building authority approvals are valid.

In the manhole connection area, swelling tapes (auxiliary materials) must be placed between the existing pipe and before the PE protective hose (PE-preliner) is inserted. In areas where swelling tapes (auxiliary tapes) cannot be used for constructional reasons, the watertight design of the connection areas between the hose liner and the manhole can also be carried out in the following manner after the hose liner has been installed:

a) Connection of the hose liners by means of reaction resin filler, for which a general construction approval is valid,
b) Connection of the hose liners by means of mortar systems for which a general construction supervision approval is valid,
c) GRP laminates,
d) Grouting with polyurethane (PU) or epoxy (EP) resins for which a general building authority approval is valid,
e) Installation of hose liner end sleeves for which a general construction approval is valid.

2.1 Properties and composition

Where applicable, the hose liners described in section 1 comply with the requirements of DIN EN ISO 11296-42 and have the specific properties and compositions listed below.

2.1.1 Materials of the process components in the "M" state

2.1.1.1 Materials for the inversion hoses

The materials of the polyurethane-coated polyester fiber hoses, the polyethylene protective hose (PE-Preliner), the calibration hoses and the materials of the epoxy resin, the three hardeners and the other materials, correspond to the formulation data deposited with the German Institute for Construction Technology.

1a) The polyester fiber hose "ThermoLiner^{plus}" has the following properties among others:

- Felt thickness: approx. 5.0 mm
- End wall thickness of hose liner: min. 3.0 mm
- Basis weight at 5.0 mm felt thickness: approx. 550 g/m^2
- PU coating thickness: approx. 260 µm
- Maximum tensile force elongation lengthwise according to DIN EN 29073-33: 60 % to 100
- Maximum tensile force-elongation transverse according to DIN EN 29073-33: 80 % to 1
- Total weight: ca. 800 g/m^2
- Pore volume at 5.0 mm felt thickness: approx. 85 %

1b) The polyester fiber hose "ThermoLiner" with 3.5 mm wall thickness has the following features

Properties:

- Felt thickness: approx. 3.5 mm
- End wall thickness of hose liner: min. 3.0 mm
- Basis weight at 3.5 mm felt thickness: approx. 500 g/m^2
- PU coating thickness: approx. 350 µm
- Maximum tensile force elongation longitudinal DIN EN 29073-33: 65 % to 100 %
- Maximum tensile force-elongation transverse DIN EN 29073-33: 90 % to 150 %
- Total weight ca. 850 g/m^2
- Pore volume at 3.5 mm felt thickness: approx. 85 %

1c) The polyester fiber hose "ThermoLiner" with a wall thickness of 5.0 mm features the following

Properties:

- Felt thickness: approx. 5.0 mm
- End wall thickness of hose liner: min. 4.5 mm
- Basis weight at 5 mm felt thickness: approx. 800 g/m^2
- PU coating thickness: approx. 350 µm
- Maximum tensile force elongation longitudinal DIN EN 29073-33: 65 % to 100 %
- Maximum tensile force-elongation transverse DIN EN 29073-33: 90 % to 150 %
- Total weight ca. 1.150 g/m^2
- Pore volume at 5 mm felt thickness: approx. 85 %

DIN EN ISO 11296-4 Plastic piping systems for the renovation of buried non-pressurized Drainage networks (open-channel lines) - Part 4: Field-hardenable tubular linings (ISO 11296-4:2009, corrected version 2010-06-01); German version EN ISO 11296-4:2011; edition:2011-07 DIN EN 29073-3 Textiles; test methods for nonwovens; - Part 3: Determination of maximum tensile strength and the maximum tensile elongation (ISO 9073-3:1989); German version EN 29073-3: 1992; Edition:1992-08

1d) The polyester fiber hose "ThermoLiner M" with a wall thickness of 5.5 mm to 12.0 mm has among other things, the following properties:

- Felt thickness:	approx. 5.5 mm to 12.0 mm
- End wall thickness of hose liner:	min. 4,5 mm to 10,5 mm
- Basis weight Felt thickness:	1,100 g/m2 to 2,200 g/m^2
- PU coating thickness:	approximately 400 µm
- Maximum tensile force elongation along DIN EN 29073-33:	approx. 120
- Maximum tensile force-elongation transverse DIN EN 29073-33:	approx. 90 %
- Total weight	1,550 g/m2 to 2,650 g/m^2
- Pore volume:	approx. 85 %

Further properties can be found in Annex 2.

2a) The epoxy resin has the following properties before processing:

- Component A (resin) "EasyPox Resin":	
- Density according to DIN EN ISO 2311-2" at +23 °C:	1,13 g/cm^3 to 1,20 g/cm^3
- Viscosity according to DIN EN ISO 2884-16 at +25 °C:	1,600 mPa x s to 2,400 mPa x s
- Color:	grey

2b) The three hardeners have the following properties before processing:

- Component B (hardener) "EasyPox 3008":	
- Density according to DIN EN ISO 2811-24 at +23 °C:	0,90 g/cm^3 to 1,10 g/cm^3
- Viscosity according to DIN EN ISO 2884-16 at +25 °C:	130 mPa x s to 210 mPa x s
- pH value:	12
- Pot life:	22 minutes to 30 minutes
- Color:	yellowish-brownish
- Component B (hardener) "EasyPox 6024":	
- Density according to DIN EN ISO 2811-24 at +23 °C:	0,90 g/cm3 to 1,10 g/cm3
- Viscosity according to DIN EN ISO 2884-15 at +25 °C:	20 mPa x s to 40 mPa x s
- pH value:	12
- Pot life:	50 minutes to 65 minutes
- Color:	yellowish-brownish
- Component B (hardener) "EasyPox T0530":	
- Density according to DIN EN ISO 2811-24 at +23 °C:	0.93 g/cm3 to 1.00 g/cm3
- Viscosity according to DIN EN ISO 2884-15 at +25 °C:	10 mPa x s to 50 mPa x s
- pH value:	10 to 12
- Pot life:	5 hours to 9 hours
- Color:	milky / cloudy

DIN EN ISO 2811-2	Paints and varnishes - Determination of density - Part 2: Immersion method (ISO 2811 -2:2011); German version EN ISO 2811 -2:2011; Edition:2011 - 06Paints and
DIN EN ISO 2884-1	varnishes - Determination of viscosity using rotational viscometers - Part 1: High velocity cone-plate viscometer (ISO 2884-1:1999); German version EN ISO 2884-1:2006; Edition:2006-09

3) The three epoxy resin systems have the following properties without the PU liner in the cured state

- Resin system "EasyPox 3008" (cold-curing resin system):
  - Density at +23 °C according to DIN EN ISO 1183-16: ~ 1.20 g/cm3
  - Flexural modulus of elasticity according to DIN EN ISO 1787: > 3,600 N/mm2
  - Bending stress according to DIN EN ISO 1787: ≥ 80 N/mm2
  - Bending strain at bending strength according to DIN EN ISO 1787: ≥ 1,5 %
  - Tensile modulus of elasticity according to DIN EN ISO 527-28: ≥ 3,400 N/mm2
  - Tensile strength according to DIN EN ISO 527-28: ≥ 45 N/mm2
  - Elongation at break according to DIN EN ISO 527-28: ≥ 1,2 %
  - Processing time at approx. +15 °C to +20 °C: ~ 30 minutes
  - Curing time at approx. +15 °C to +20 °C: ~ 8 hours
- Resin system "EasyPox 6024" (cold-curing resin system):
  - Density at +23 °C according to DIN EN ISO 1183-16: ~1.19 g/cm3
  - Flexural modulus of elasticity according to DIN EN ISO 1787: ≥ 3,400 N/mm2
  - Bending stress $_{ofB}$ according to DIN EN ISO 1787: ≥ 75 N/mm2
  - Bending strain at bending strength e_{fM} according to DIN EN ISO 1787: ≥ 2,0 %
  - Tensile modulus of elasticity according to DIN EN ISO 527-28: > 3,300 N/mm2
  - Tensile strength according to DIN EN ISO 527-28: ≥ 50 N/mm2
  - Elongation at break according to DIN EN ISO 527-28: ≥1,2%
  - Processing time at approx. +15 °C to +20 °C: ~ 60 minutes
  - Curing time at approx. +15 °C to +20 °C: ~ 24 hours
- Resin system "EasyPox T0530" (thermosetting resin system):
  - Density at +23 °C according to DIN EN ISO 1183-16: ~ 1.19 g/cm3
  - Flexural modulus of elasticity according to DIN EN ISO 1787: ≥ 3,100 N/mm2
  - Bending stress $_{ofB}$ according to DIN EN ISO 1787 :≥ 100 N/mm2
  - Bending strain at bending strength according to DIN EN ISO 1787: ≥ 3,0 %
  - Tensile modulus of elasticity according to DIN EN ISO 527-28: ≥ 3,200 N/mm2
  - Tensile strength according to DIN EN ISO 527-28: ≥ 50 N/mm2
  - Elongation at break according to DIN EN ISO 527-28: ≥ 1,8 %
  - Working time at approx. +15 °C to +20 °C: 4 to 5 hours
  - Curing time at approx. +65 °C: ~ 4 hours

DIN EN ISO 1183-1	Plastics - Methods for determining the density of non-foamed plastics - Part 1: Immersion method, liquid pycnometer method and titration method (ISO 1183-1:2012); German version EN ISO 1183-1:2012, Edition:2013-04
DIN EN ISO 178	Plastics - Determination of flexural properties (ISO 178:2010); German version EN ISO 178:2010; Edition:2011-04
DIN EN ISO 527-2	Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion compounds (ISO 527-2:1993 including Cor.1:1994); German version EN ISO 527-2:1996; Edition:1996-07

Only epoxy resins that comply with the formulation specifications and IR spectra deposited with the German Institute for Construction Technology may be used. The IR spectra must also be deposited with the third-party monitoring agency.

2.1.1.2 Material of the swelling strip

Only extruded profiles consisting of a chloroprene (CR/SBR) rubber and water-absorbent resin may be used for the swelling tape (auxiliary material) in the area of the manhole connection (Annex 19) of the hose liner. The swelling tapes must have a volume increase of at least 100 % after 72 h when stored in water.

2.1.2 Hose liner in "I" state

2.1.2.1 Wall thicknesses and wall structures

Depending on the system, resin-impregnated pipe liners are used for rehabilitation measures, which have a minimum wall thickness of 3 mm after inversion and curing (tables in appendices 3 to 5).

Sewage pipes whose load-bearing capacity is given alone (without support of the surrounding soil), i.e. no cracks (except hairline cracks with crack widths less than 0.15 mm or, in the case of reinforced concrete pipes, less than 0.3 mm), may only be rehabilitated with hose liners in accordance with Appendices 3, 4 and 5 if the minimum wall thickness is not less than 3 mm and a nominal stiffness SN > 500 N/m2 is maintained. If there are one or more continuous longitudinal cracks in the old pipe, soil investigations, e.g. by dynamic probing, are required and a corresponding mathematical proof must be provided. In the case of infiltrations, the liner must be dimensioned with regard to its deformation and buckling behavior.

If the old pipe floor system alone is no longer capable of bearing the load, such waste water pipes with hose liners may only be rehabilitated with wall thicknesses listed in Appendices 3 to 5 if the static loads to be absorbed by the hose liner are verified by a static calculation in accordance with Worksheet DWA-A 143-29.

The following relationships apply to the nominal stiffness SN and short-term ring stiffness SR:

For SN applies:

$$SN = \frac{E \cdot s^3}{12 \cdot d_m^3}$$

For SR applies:

$$SR = \frac{E \cdot s^3}{12 \cdot r_m^3}$$

(SN = nominal stiffness based on DIN 16869-210) (rm= radius of center of gravity)

For the groundwater load case, the hose liner must be dimensioned with regard to dents in accordance with worksheet DWA-A 143-29 (see also Section 9).

The hose liners have a three-layer wall structure with a protective film that is to be pulled in. This consists of the polyethylene protective hose (PE-preliner), the polyester fiber hose and the polyurethane coating (Appendix 1). The polyester fiber hose consists of felt layers with wall thicknesses of approx. 3.5 mm to approx. 12.0 mm, after impregnation and curing with wall thicknesses of at least 3.0 mm to 10.5 mm (appendix 3 to 5).

2.1.2.2 Physical characteristics of the cured hose liner

After curing of the polyester fiber layer impregnated with resin and hardener (without the PE-preliner and the PU inner coating) it must have the following characteristic values:

DWA-A 143-2Deutsche	Vereinigung für Wasserwirtschaft, Abwasser und Abfall e. V. (DWA) -Worksheet 143: Renovation of drainage systems outside of buildings -Part 2: Structural calculations for the renovation of sewers and drains with lining and installation methods; Issue:2015-07
DIN 16869-2Pipes	of glass fiber reinforced polyester resin (UP-GF), centrifugally cast, filled - Part 2: General quality requirements, testing; Edition:1995-12

- Resin system "EasyPox 3008" (cold-curing resin system) with the polyester fiber hoses, ThermoLinerplus" and "ThermoLiner 3.5 mm and 5.0 mm":
  - Density according to DIN EN ISO 1183-16: ~ 1.12 g/cm³
  - Short-time circumferential E-modulus according to DIN EN 122811: ≥ 2,820 N/mm²
    Flexural modulus of elasticity according to DIN EN ISO 11296-42
    or DIN EN ISO 1787: ~ 2,670 N/mm²
  - Bending stress $_{ofB}$ according to DIN EN ISO 11296-42
    or DIN EN ISO 1787: ~ 75 N/mm²
  - Tensile strength according to DIN EN 139312
    or DIN EN ISO 527-413: ~ 28 N/mm²
  - Compressive stress according to DIN EN ISO 60414: ~ 73 N/mm²
- Resin system "EasyPox 6024" (cold-curing resin system) with the polyester fiber hoses "ThermoLiner^{plus}" and "ThermoLiner 3.5 mm and 5.0 mm":
  - Density according to DIN EN ISO 1183-16: ~ 1.18 g/cm³
    Short-time circumferential E-modulus according to DIN EN 122811: ≥ 2,650 N/mm²
  - Flexural modulus of elasticity according to DIN EN ISO 11296-42
    or DIN EN ISO 1787: ~ 2,750 N/mm²
  - Bending stress $_{ofB}$ according to DIN EN ISO 11296-42
    or DIN EN ISO 1787: ~ 55 N/mm²
  - Tensile strength according to DIN EN 139312
    or DIN EN ISO 527-413: ~ 38 N/mm²
  - Compressive stress according to DIN EN ISO 60414: ~ 84 N/mm²
- Resin system "EasyPox T0530" (thermosetting resin system) with the polyester fiber hoses "ThermoLiner^{plus}", "ThermoLiner 3.5 mm and 5.0 mm" and "Thermo Liner M":
  - Density according to DIN EN ISO 1183-16: ~ 1.10 g/cm³
  - Short-time circumferential E-modulus according to DIN EN 122811: ≥ 2,500 N/mm²
  - Flexural modulus of elasticity according to DIN EN ISO 11296-42
    or DIN EN ISO 1787: ~ 2,300 N/mm²
  - Bending stress $_{ofB}$ according to DIN EN ISO 11296-42
    or DIN EN ISO 178': ~ 50 N/mm²
  - Tensile strength according to DIN EN 139312
    or DIN EN ISO 527-413: ~ 27 N/mm²
  - Compressive stress according to DIN EN ISO 60414: ~ 76 N/mm²

DIN EN 1228	Plastics piping systems - Pipes made of glass fiber reinforced thermosetting plastics (GRP) - Determination of the specific initial hoop stiffness; German version EN 1228:1996; Ausgabe: 1996-08
DIN EN 1393	Plastics piping systems - Glass fiber reinforced thermosetting plastic (GRP) pipes - Determination of initial longitudinal tensile properties; German version EN 1393:1996; Edition:1996-12
DIN EN ISO 527-4	Plastics - Determination of tensile properties - Part 4: Test conditions for iso-tropic and anisotropic fiber reinforced plastic composites (ISO 527-4:1997); German version EN ISO 527-4:1997; Edition:1997-07
DIN EN ISO 604	Plastics - Determination of printing properties (ISO 604:2002); German version EN ISO 604:2003; Edition:2003-12

2.1.2.3 Properties of the cured polyester fiber resin composite based on thermal analysis (DSC analysis)

The cured polyester fiber resin composite has the following limit values, which were determined by means of Differential Scanning Calorimetry (DSC)

1. Glass transition temperature TG1	(Actual state of the reaction resin system; first heating phase)	
- "EasyPox 3008"		≥ +60 °C
- "EasyPox 6024"		≥ +60 °C
- "EasyPox T0530"		≥ +67 °C
2. Glass transition temperature TG2	(Resin system in fully cured condition; second heating phase)	
- "EasyPox 3008"		≥ +90 °C
- "EasyPox 6024"		≥ +80 °C
- "EasyPox T0530"		≥ +81 °C

2.1.3 Environmental Compatibility

The construction product fulfils the requirements of the "Principles for the assessment of the effects of construction products on soil and groundwater" (version: 2011; publications of Deutsches Institut für Bautechnik). This statement is only valid if the special provisions of this general building approval are observed.

The reservation of permission, especially in water protection zones, from the competent water authority remains unaffected.

2.2 Production, packaging, transport, storage and labelling

2.2.1 Production of the hose liners

The polyester fiber hoses shall be manufactured at the supplier's works with the minimum wall thicknesses specified in section 2.1.1.1 and shall be coated with a flexible polyurethane coating.

The applicant has to ensure that the upstream supplier complies with the specified length dimensions and wall thicknesses.

To check the properties of the epoxy resin and the three hardeners according to section 2.1.1.1 in accordance with the formulation specifications, the applicant shall have factory certificates 2.2 based on DIN EN 1020416 submitted by the upstream supplier with each delivery.

The following properties are to be checked during the incoming goods inspection:

Properties of the resin components:

- Density
- Viscosity
- Reactivity

2.2.2 Packing, transport, storage

The polyester fiber hosess supplied by the upstream supplier, coated on one side, shall be stored on the premises of the applicant before further use in such a way that they are not damaged.

The resin impregnation components delivered by the upstream supplier to the respective construction site must be stored in suitable, separate, airtight containers on the applicant's premises until further use. The temperature range for the epoxy resin (component A) and the three hardeners (components B) from approx. +5 °C to

DIN EN 10204 Metallic products - Types of inspection certificates: German version EN 10204:2004; Edition:2005-01

approx. +30 °C must be maintained. The storage time for the two-component epoxy resin systems "EasyPox 3008", "EasyPox 6024" and "EasyPox T0530" is approx. one year after delivery and must not be exceeded. The containers must be protected from direct sunlight. The containers must be designed in such a way that the resins and hardeners are stored in separate individual containers.

The quantities of the components required for the remediation measures shall be taken from the storage containers and transported to the respective place of use in suitable, separate and airtight containers. At the place of use, the containers are to be protected from the effects of the weather. The polyester fiber hoses must be transported in suitable transport packaging in such a way that they are not damaged.

During storage and transport, the relevant accident prevention regulations and the information in the applicant's manual of procedures must be observed.

2.2.3 Identification

The polyester fiber hoses and the respective transport containers of the resin components must be marked with the conformity mark (Ü mark) in accordance with the conformity mark regulations of the countries, including the approval number Z-42.3-414. The marking may only be carried out if the requirements according to Section 2.3 Proof of Conformity are fulfilled.

The manufacturer must state the hazard symbols and H and P phrases on the containers, on the packaging, the package insert or in the delivery note in accordance with the Hazardous Substances Regulation and the EU Regulation No. 1907/2006 (REACH) as well as the respective current version of the CLP Regulation (EC) 1272/200816. The packaging must be marked according to the rules of ADR17 in the respective valid versions.

In addition, the following data must be indicated on the transport packaging of the polyester fibre hoses:

- "ThermoLiner 3.5 mm and 5.0 mm", "ThermoLiner^{plus}" and "ThermoLiner M"
- Felt thickness
- Nominal diameter
  Width or nominal diameter
- Batch number

In addition, the transport containers of the resins and hardeners must be marked at least as follows

- Component designation A (resin: "EasyPox Resin") and component designations B (hardener: "EasyPox 3008", "EasyPox 6024" and "EasyPox T0530")
- Temperature range
  Package contents (volume or weight indication)
- Labelling according to the Ordinance on Hazardous Substances (Gefahrstoffverordnung), if applicable

2.3 Certificate of conformity

2.3.1 General information

Confirmation of conformity of the process components with the provisions of this general type approval shall be provided for each manufacturing plant by means of a certificate of conformity based on factory production control and regular third-party surveillance including initial inspection of the process components in accordance with the following provisions.

1272/2008 Regulation	(EC) No 1272/2008 on classification, labelling and packaging cation of substances and mixtures
[17] ADR European	Agreement concerning the International Carriage of Dangerous Goods by Road
	Goods by road *(Accord europeen relatif au transport international des marchandises Dangereuses par Route)*

For the issue of the certificate of conformity and external monitoring, including the product tests to be carried out in this connection, the manufacturer shall involve a certification body recognized for this purpose and a monitoring body recognized for this purpose.

The declaration that a certificate of conformity has been issued shall be made by the manufacturer by marking the construction products with the mark of conformity (Ü mark) indicating the intended use.

Deutsches Institut für Bautechnik shall be notified by the certification body of a copy of the certificate of conformity issued by it.

In addition, a copy of the initial test report shall be sent to Deutsches Institut für Bautechnik for information.

2.3.2 Factory production control

A factory production control system shall be established and implemented in each manufacturing plant. Factory production control means the continuous surveillance of production to be carried out by the manufacturer in order to ensure that the construction products manufactured by him comply with the provisions of this general building control certificate.

The factory production control shall include at least the measures listed below.

- Description and verification of the output material

  With each delivery of the components PE, PU and PVC films, polyester needle felt, the resin and the three hardeners and other materials, the operator of the manufacturing plant must ensure that the required properties according to section 2.1.1 are complied with.

  For this purpose, the operator of the manufacturing plant must have the respective upstream supplier of the two-component epoxy resin systems present the corresponding factory certificates 2.2 for components A and B and factory certificates 2.1 based on DIN EN 1020415 for the polyester fiber hoses, foils, expanding tape and other manhole connection materials.

  Within the framework of the incoming goods inspection, the properties mentioned in Section 2.1.1.1 and Section 2.1.1.2 shall also be checked by random sampling.

- the checks and tests to be carried out during manufacture:

  The requirements of section 2.2.1 shall be verified.

- Check the containers:

  For each batch of resin, the labelling requirements shall be checked in accordance with section 2.2.3.

The results of factory production control shall be recorded. The records shall contain at least the following information:

- Name of the construction product or of the starting product and of the constituents
- Type of control or audit
- date of manufacture and testing of the construction product or starting material
- the results of the checks and tests and, where applicable, comparison with the requirements
- Signature of the person responsible for factory production control

The records must be kept for at least five years and presented to the inspection body engaged for external monitoring. They must be presented to Deutsches Institut für Bautechnik and the responsible supreme building supervisory authority on request.

If the test result is unsatisfactory, the manufacturer shall immediately take the necessary measures to remedy the defect. Construction products which do not comply with the requirements shall be handled in such a way as to avoid confusion with conforming products. After remedy of the defect, the test in question shall be repeated immediately, if technically possible and necessary to prove that the defect has been remedied.

2.3.3 External monitoring

In each manufacturing plant, the factory production control shall be regularly checked by an external inspection, at least once every six months.

An initial inspection of the process components must be carried out as part of the third-party inspection. The factory production control shall be carried out within the scope of the external surveillance by random sampling. The requirements of Secs. 2.1.1 and 2.2.3 shall be checked.

In addition, the manufacturing requirements of section 2.2.1 shall be checked at random. This also includes checking the curing behavior, density, storage stability and weight per unit area, as well as IR spectroscopy.

Sampling and testing are the responsibility of the recognized inspection body. In the case of third-party monitoring, the works certificates 2.1 and works certificates 2.2 must also be checked in accordance with DIN EN 1020415.

The results of certification and third-party monitoring must be kept for at least five years. They shall be presented by the certification body or the inspection body to Deutsches Institut für Bautechnik and the competent supreme building supervisory authority on request.

3 Provisions for planning

The details of the pipe data must be checked, e.g. line layout, depth position, position of house connections, lateral connections, manhole depths, ground water, pipe connections, hydraulic conditions, inspection openings, cleaning intervals. Existing video recordings must be evaluated according to the application. The correctness of the information must be checked on site. An assessment of the condition of the existing sewer pipe, with regard to the applicability of the rehabilitation method, must be carried out.

The hydraulic effectiveness of the wastewater pipes must not be impaired by the installation of a hose liner. A corresponding proof must be provided if necessary.

4 Provisions for implementation

4.1 General information

The "EasyLiner" hose lining method can be implemented under the following structural conditions:

a) from start to finishing point

b) from start to finishing point through an intermediate manhole

c) Starting from the starting point in a rehabilitation section, with a defined length, without the need for another manhole opening

d) Lateral connections, starting from the starting point to the connection point in the main line

A prerequisite is that sufficiently large areas are available to set up a compressed air inversion device or inversion scaffolding.

Between the respective start and finishiung points, several manholes can be crossed, including the crossing of manholes with channel deflections. Crossings of channel deflections and up to two bends up to 90° can be rehabilitated. If wrinkles occur, they must not be larger than specified in DIN EN ISO 11296-42.

Lateral connections can be sealed either in open construction or by means of a renovation procedure. General building authority approvals must be available for the selected method.

The applicant shall draw up a manual describing the individual steps relating to the implementation of the rehabilitation procedure.

The applicant shall also ensure that those carrying out the work are adequately familiarized with the procedure. The sufficient expertise of the company carrying out the work can be verified by a corresponding quality mark from Güteschutz Kanalbau e. V. [18] be documented.

Equipment and facilities

4.2

At least the following devices, components and equipment are necessary for a successful renovation:

- Devices for sewer cleaning
- Equipment for dewatering
- Devices for duct inspection (DWA-M 149-219)
- Refurbishment facilities / vehicle equipment:

  polyurethane-coated polyester fiber hoses in the appropriate nominal diameters ("ThermoLiner^{plus}" and/or "ThermoLiner 3.5 mm and 5.0 mm" and/or "ThermoLiner M"; Appendix 2)

  - nominal size related polyethylene protective hoses (PE-Preliner)
  - Container with the epoxy resin "EasyPox" and the three hardeners "EasyPox 3008", "EasyPox 6024" (cold-curing resin systems) and/or "EasyPox T0530" (hot-curing resin system)
  - Installation for dosing and mixing the resin systems
  - Scale, filling nozzle
  - Impregnation point protected from the weather (table with conveyor belt or roller table or roller drive, if necessary with suction device

    Vacuum system with vacuum monitoring device, vacuum pump with suction hose and suction cups
  - Cooling system/air conditioning unit in the renovation vehicle
  - Inversion hose, inversion nozzles and bends suitable for the respective nominal width
  - Compressed air inversion device and inversion device with the designation "Inverter®" (inversion drum Annex 8) with pressure monitoring device and accessories and/or inversion frame (Annex 9)
  - Pressure hoses for connection to the inversion drum and/or filling hoses
  - Heating system/unit and accessories (Annex 14 and 15)

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DWA-M 149-2Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e. V. (DWA)
- Leaflet 149: Condition monitoring and assessment of drainage systems outside buildings
- Part 2: Coding system for optical inspection; Issue:2006-11

- Shut-off plugs or shut-off discs suitable for the respective nominal size
- Support tubes or support hoses for sample collection on the construction site (suitable for the respective nominal diameter)
- Temperature and pressure resistant calibration hose suitable for the respective nominal diameter
- Steam plant with accessories for steam curing (annex 16)
- Control devices for the steam temperature
  Steam outlet valve
- Pressure gauge
- Steam venting device
- Safety ropes and draw-in bands
- Camera, control unit with screen
- Power generator
- Compressor
- Water supply
- Power supply
- Feed pumps
- Container for waste materials
- Temperature sensor
- Temperature monitoring and recording apparatus
- Small devices
- Compressed air tools such as compressed air drill, compressed air angle cutter
- Hand tools, fixing rods, ropes, rope drum, hoses
- if necessary, social and sanitary rooms

If electrical devices, e.g. video cameras (or so-called sewer remote eyes) are installed in the line to be rehabilitated, they must be in accordance with VDE regulations.

4.3 Implementation of the remediation measure

4.3.1 Preparatory measures

Prior to the rehabilitation measure, it must be ensured that the pipe in question is not in operation; if necessary, appropriate shut-off plugs must be installed and the wastewater diverted. The sewer pipe to be rehabilitated must be cleaned to such an extent that the damage can be properly detected on the monitor. If necessary, obstacles are to be removed (e.g. root ingrowths, intruding house connection pipes, etc.). When removing such obstacles, make sure that this is only done with suitable tools so that the existing waste water pipe is not additionally damaged.

The accident prevention regulations applicable to the application of the rehabilitation procedure must be observed.

Devices of the rehabilitation procedure that are to be installed in the pipeline section to be rehabilitated may only be used if it has been ensured beforehand by testing that no flammable gases are present in the pipeline section.

For this purpose, the relevant sections of the following regulations must be observed:

- GUV-R 12620 (previously GUV 17.6)
- DWA leaflet 149-219
- DWA-A 199-1 and DWA-A 199-221

The accuracy of the information referred to in Section 3 shall be verified on the spot. For this purpose, the section of pipe to be rehabilitated must be cleaned with standard high-pressure flushing equipment to such an extent that the damage can be clearly identified on the monitor during the visual inspection according to Code of Practice DWA-M 149-219.

When using steam generators and devices for steam curing, in particular the law on technical working materials (Device Safety Act) and the Ordinance on Steam Boiler Systems (Steam Boiler Ordinance) must be observed.

When persons enter the manholes of the sewer pipes to be rehabilitated and during all steps of the rehabilitation procedure, the relevant accident prevention regulations must also be observed.

The steps required to carry out the process shall be recorded using record sheets (e.g. Appendices 20 to 22) for each impregnation and remediation operation.

4.3.2 Incoming inspection of the process components on the construction site

The transport containers of the process components shall be checked to ensure that the markings referred to in section 2.2.3 are present. The circumference of the polyester fiber hose in relation to the object to be rehabilitated shall be measured before impregnation with resin. Compliance with the storage or transport temperature to be maintained prior to resin impregnation in accordance with Section 2.2.2 shall be checked.

4.3.3 Arrangement of support tubes and support hoses

Before the protective hose (PE-Preliner) is inserted, support pipes or support hoses may have to be positioned to extend the sewer line to be rehabilitated or in the area of intermediate manholes so that samples can be taken at these points to complete the rehabilitation measure.

4.3.4 Pulling in or inversion of the protective hose (PE-Preliner)

The PE-Preliner should be placed in the sewer pipe to be rehabilitated in such a way that damage is avoided. The PE-Preliner is either to be drawn in or pressurized with compressed air and inverted into the wastewater pipe to be rehabilitated. The swelling tapes to be used for the watertight connection of the hose liner must be positioned in the area of the manhole connections when inserting the PE-preliner.

4.3.5 Impregnation of the polyester fiber hose

4.3.5.1 Resin mixture

The resin quantity required for resin impregnation of the respective polyurethane-coated polyester fiber hose "ThermoLiner^{plus}", "ThermoLiner 3.5 mm and 5.0 mm" and "ThermoLiner M" must be determined before the beginning of resin mixing, depending on the hose liner diameter, wall thickness and length (Appendices 6 and 7). The choice between the epoxy resin systems "EasyPox 3008", EasyPox 6024" (cold-curing resin systems) and

GUV-R 126	Safety rules: Working in enclosed spaces of sewage treatment plants (previously GUV 17.6); Edition:2008-09
DWA-A 199-1	German Association for Water, Wastewater and Waste (DWA) -Working Sheet 199: Service and operating instructions for the personnel of sewage plants , -Part 1: Service instructions for the personnel of sewage plants; Issue no. 2011-11
DWA-A 199-2	German Association for Water, Wastewater and Waste (DWA) -Working Sheet 199: Service and operating instructions for the personnel of wastewater treatment plants , - Part 2: Operating instructions for the personnel of sewer networks and stormwater

"EasyPox T0530" (thermosetting resin system) depends on the processing times as well as the curing and heating times (Appendix 18).

The weight mixing ratio of the epoxy resin "EasyPox" and the hardener "EasyPox 3008" is 100:25 kg (4:1) by weight, "EasyPox 6024" is 100:25 kg (4:1) by weight and the hardener "EasyPox T0530" is 100:30 kg (3.33:1) by weight.

With the aid of an electrically operated stirring device, hardener component B is to be mixed uniformly with the epoxy resin (component A) in the mixing vessel without bubbles forming. A mixing temperature of approx. +5 °C to approx. +25 °C must be maintained. Ensure that no air is mixed in.

The mixing of the resin system and the temperature conditions shall be recorded in a report as described in section 4.3.1. In addition, a reference sample of each resin mixture shall be taken at the site to check and record the curing behavior.

4.3.5.2 Resin impregnation

The "ThermoLiner 3.5 mm and 5.0 mm" and the "ThermoLiner^{plus}" can be impregnated with all three resin systems "EasyPox 3008", "EasyPox 6024" and "EasyPox T0530". The "ThermoLiner M" can only be impregnated with the resin system "EasyPox T0530".

The "EasyLiner" must be prepared approx. 1 m longer than the length of the sewer pipe to be rehabilitated. The polyester fiber hose is to be rolled out on the conveyor table in a weather-protected or air-conditioned room or in the rehabilitation vehicle, and if necessary, it is to be attached to suitable equipment. To support the resin impregnation, the air contained in the polyurethane-coated polyester fiber hose must be removed to a large extent.

The end of the hose liner must be turned over by approx. 0.1 m (brim). Behind the brim, the hose liner is to be folded like a "Z" and weighted down with a weight and thus sealed airtight. Then a vacuum cut approx. 15 mm long is to be made in the top coating of the hose liner. For hose liner lengths from 10 m, vacuum cuts must be made every 8 m to 10 m. These cuts must not be made in the seam area. The suction nozzles of the vacuum system must now be placed on these cuts. A "Z" must also be folded behind each suction socket and weighted down with a weight. A corresponding negative pressure of approx. 500 mbar must be created in the hose liner.

At the "Z" fold immediately behind the brim of the hose liner, the filling hose for the resin system must be attached and the hose liner must be filled with the resin mixture. During the filling process, a vacuum of 0.5 bar must be constantly maintained via the suction cups on the hose liner. For even distribution of the resin in the polyester fiber hose, the liner is then conveyed either by calibration rollers or by a roller drive. The hose liner should be placed between the pressure rollers. The rolling distance must be set to twice the wall thickness of the liner. The operating and maintenance instructions for the resin impregnation devices or equipment must be observed.

The feed rate should be selected so that the resin is distributed as evenly as possible in the matrix of the polyester fiber hose. The speed of the impregnation process depends on the suction or penetration behavior of the resin mixture. If the resin distribution is noticeably uneven, the hose liner should be conveyed through the calibration roller again. After the even distribution of the resin quantity in the hose liner, the cut opening of the hose liner must be closed airtight. In order to reduce friction during the subsequent inversion and to avoid unnecessary temperature increases, the hose liner should either be sprayed with biodegradable lubricant immediately after passing through the rollers or placed in a container with a biodegradable lubricant, whereby the hose liner should be folded together in such a way that the PU coating is not damaged.

The curing time and the temperature curve shall be recorded in the protocol according to section 4.3.1.

4.3.6 Inversion and curing of the resin impregnated polyester fiber hose

First of all, a PE-preliner must be pulled in or inverted in the case of working in groundwater-saturated zones. The PE-Preliner should prevent resin from the polyester fiber hose from penetrating through the damaged areas into the surrounding soil.

To invert the PE-preliner, it must be sealed airtight at both ends, with a compressed air connection at one end. The PE-Preliner is to be turned up to half the length that is to be drawn in. It is then to be inserted from the starting manhole into the sewer pipe to be rehabilitated and inverted by means of pressurization.

4.3.6.1 Inverting the resin-impregnated polyester needle felt tube by means of compressed air through a compressed air inversion device (Appendix 8)

a) Inverting with closed end (Close-End method) (Appendix 10)

A support pipe (flexible hose) with a deflection bend (inversion elbow) (Appendix 8) related to the diameter of the sewer pipe to be rehabilitated is to be inserted into the starting manhole. This support pipe must be attached to the compressed air inversion device. After the impregnation process is complete, the hose liner must be rolled into the compressed air inversion device. For this purpose, the control tape is fastened to the beginning of the hose liner to be sealed (in the case of warm curing, the heating hose must also be fastened here). The control tape must be connected to the compressed air inversion device and must be at least 3 m longer than the hose liner to be inserted. The PU liner is to be rolled into the compressed air inversion device using the control tape. The open end of the hose liner is to be pulled through the pressure hose and rolled over the edge of the attachment ring on the metal pipe and fastened with fabric tension belts or clamps.

The end of the hose liner and the inversion bend (deflection bend) must be inserted into the starting manhole or into the inspection or cleaning opening and positioned in the PE protective hose at the beginning of the pipe to be rehabilitated, if necessary. The resin-impregnated hose liner is pressurized with compressed air, which causes the carding process. The compressed air inversion device must be subjected to an inversion pressure of approx. 0.3 bar. This inversion process continues until the target manhole or the inspection opening or the target point of the sewer pipe to be rehabilitated is reached. Through this process, the resin-impregnated inner side of the hose liner either comes into contact with the inner side of the PE-preliner or directly into contact with the inner surface of the sewer pipe to be rehabilitated. This way, the polyurethane coating becomes the side facing the wastewater.

1. Cold curing:
   A calibration pressure of approx. 0.3 bar must be maintained until the hose liner has cured. The curing times under ambient temperatures at approx. +10 °C are approx. 8 hours ("EasyPox 3008") to 24 hours ("EasyPox 6024"). The curing times in Appendix 18 must be observed.
2. Hot curing:
   Due to the inversion of the hose liner, the heating hose previously attached to the closed hose liner start is also inverted at the same time. The end of the heated hose must be connected to the heating system/unit (system 14) after completion of the inversion. The hose liner must be completely filled with water so that the positive fit to the inner surface of the sewer pipe to be rehabilitated is maintained. A calibration pressure of approx. 0.3 bar must be maintained throughout the entire hardening period. The hot water generated in the heating unit is to be pumped in the heating circuit. When the temperature between the old pipe and the hose liner has reached approx. +60 °C, the curing time of the resin system "EasyPox T0530" is approx. 4 hours to 8 hours (Appendix 17 and 18).

The temperature between the old pipe and the hose liner must be measured and recorded.

After completion of the curing process, the heating water and the hose liner must be cooled down to approx. +25 °C to +20 °C by adding cold tap water. A cooling phase of approx. 1 hour is to be observed and not fallen short of. The water must be drained off after reaching this temperature level.

3. Steam curing:
For steam curing, a pressure hose with a discharge valve must be installed in the area of the target manhole (system 16). Temperature sensors are to be arranged at the steam inlet as well as the steam outlet to determine and record the steam temperature during the curing process. The hose liner is to be sealed and set up with compressed air of approx. 0.3 bar. The steam generator must be put into operation. The steam is to be introduced at the start manhole via the steam valve. The steam pressure must be continuously 0.3 bar. At the beginning of the curing process, the temperature must be increased continuously to +65 °C and maintained for 30 minutes. Afterwards, the temperature must be increased gradually to +80 °C. The temperatures shall be maintained constantly for 2 hours in accordance with Appendix 17. For this purpose, the steam pressure must be monitored by means of a manometer and the steam temperature must be regulated by means of a thermometer and the respective outlet valve in the target manhole according to the instructions in the manual. This temperature of +80 °C must be maintained for approx. 2 hours. After curing is complete, the steam system must be switched off and the hose liner must be slowly cooled down to approx. +20 °C by adding cold air (30 minutes to 60 minutes).

The course of the individual pressure and temperature stages as well as their respective duration shall be recorded in a corresponding steam curing report. When carrying out the steam curing process, care must be taken to ensure that any odor nuisance is largely avoided. The curing time is approx. 3 hours to 4 hours. The curing times according to Appendix 17 must be observed.

The curing time of the hose liner depends on the resin system used according to section 2.1.1.1 as well as the heating or ambient temperatures and the heating or holding times. The curing times according to Appendix 17 and 18 must be observed. The curing time and the applied pressure must be recorded.

b) Inverting with open end (open-end method) (Annexes 11 to 13)

If the rehabilitation is carried out from a starting manhole or an inspection opening in the direction of an inaccessible sewer, the length of the liner must first be determined so that the liner does not protrude into the connection sewer. The end of the hose liner must be closed with a retaining rubber before inversion.

The hose liner closed in this way must be inverted in the following in the same way as described in section 4.3.6.1 a). At the end of the compressed air-assisted inversion process, the retaining rubber is released and the pressure in the hose liner escapes. The hose liner has not yet been applied to the inner surface of the pipe to be rehabilitated or to the previously inserted PE protective hose.

Then the calibration hose, which is closed at the end and provided with a control tape and a heating hose (in the case of warm curing), is to be attached to the attachment ring of the inversion drum as described in Section 4.3.6.1 a) and calibrated with a calibration pressure of approx. 0.3 bar in the hose liner located in the wastewater pipe to be rehabilitated. The calibration hose causes the hose liner to fit positively against the inner surface of the wastewater pipe to be rehabilitated or against the PE-preliner.

1. Cold curing:
   A calibration pressure of approx. 0.3 bar must be maintained until the hose liner has cured. The curing times in Appendix 18 must be observed.
2. Hot curing:
   After inversion of the calibration hose, the compressed air inversion device must be removed. The heating hose must be connected to the heating system/unit (Appendix 14). Then the hose liner is to be cured as described in Section 4.3.6.1 a) Point 2. by means of hot water circulation via the heating system/unit. The curing times in appendix 17 and 18 must be observed. After completion of the curing as described in Section 4.3.6.1 a) item 2, the heating water shall also be cooled to approx. +25 °C to +20 °C by adding cold tap water. A cooling phase of approx. 1 hour shall be observed and not be shorter than this. After reaching these temperature levels, the water must be drained off as described in Section 4.3.6.1 a) Item 2 and the calibration hose removed.
3. Steam curing:
   After the inversion of the calibration hose, the curing has to be carried out as described in section 4.3.6.1 a) point 3. The curing times in Annex 17 shall be observed. After curing is complete, the steam system must be switched off and the hose liner must be cooled slowly down to approx. +20 °C by adding cold air (30 minutes to 60 minutes). The calibration hose must be removed.

The curing times and temperatures as described in section 4.3.6.1 a) shall be observed.

4.3.6.2 Inversion of the resin-impregnated polyester needle felt tube by means of water gravity through an inversion tower (annex 9)

(a) Inverting with closed end (Close-End method) (Appendix 10)

A support pipe (flexible hose) with a deflection bend (inversion elbow) (Appendix 9) related to the diameter of the sewer pipe to be rehabilitated is to be inserted into the starting manhole. This support pipe is to be attached to the inversion tower or scaffolding. The hose liner is to be rolled up over a length corresponding to the height of the inversion tower or scaffolding and inserted through the support pipe. At the closed end, the control band and the heating hose are to be attached during warm curing.

The bend (inversion elbow) must be positioned between the start manhole and the transition to the sewerage system (Appendix 9). Afterwards water is to be introduced. The hydrostatic water pressure (at a scaffolding height of 3 m; 0.3 bar) causes the inversion of the hose liner. The resin-impregnated liner passes through the bend and enters the sewer pipe to be rehabilitated. Care must be taken to ensure that the inversion takes place continuously and not intermittently by controlling the amount of water added. The speed is regulated via the control belt. During inversion, the resin-impregnated inner side of the hose liner either comes into contact with the inner side of the PE-preliner or directly into contact with the inner surface of the sewer pipe to be rehabilitated. In this way, the polyurethane coating reaches the side facing the wastewater.

1. Cold curing:
   A calibration pressure of approx. 0.3 bar must be maintained until the hose liner has cured. The curing times in Appendix 18 must be observed.
2. Hot curing:
   The heating hose must be connected to the heating system/unit (system 15). Subsequently, the hose liner is to be cured as described in Section 4.3.6.1 a) Item 2. by means of hot water circulation via the heating system/unit. The curing times in appendix 17 and 18 must be observed. After completion of the curing process as described in Section 4.3.6.1 a) item 2, the heating water shall also

Addition of cold tap water to cool down to approx. +25 °C to +20 °C A cooling phase of approx. 1 hour is to be observed and not fallen short of. After reaching this temperature level, the water must be drained off as described in Section 4.3.6.1 a) Item 2.

3. Steam curing:
   Curing with steam is carried out as described in section 4.3.6.1 a) point 3. The curing times in Appendix 17 must be observed. After curing is complete, the steam system must be switched off and the hose liner must be slowly cooled down to approx. +20 °C by adding cold air (30 minutes to 60 minutes).

The curing times and temperatures as described in section 4.3.6.1 a) shall be observed.

(b) Inverting with open end (open-end method) (Appendices 11 to 13)

If the rehabilitation is carried out from a starting manhole or an inspection opening in the direction of an inaccessible sewer, the length of the liner must first be determined so that the liner does not protrude into the connection sewer. The end of the hose liner must be closed with a retaining rubber before inversion.

The hose liner closed in this way must be inverted in the following in the same way as described in section 4.3.6.2 a). During the inversion process, the retaining rubber comes loose and the water in the hose liner flows off. The hose liner is not yet applied to the inner surface of the pipe to be rehabilitated or to the previously installed PE-preliner.

Then the calibration hose, which is closed at the end and provided with a control band and a heating hose (in the case of hot curing), is to be attached to the support pipe and inverted with a calibration pressure of approx. 0.3 bar into the hose liner located in the sewer pipe to be rehabilitated. The calibration hose causes the hose liner to fit positively against the inner surface of the wastewater pipe to be rehabilitated or against the PE-preliner.

1. Cold curing:
   A calibration pressure of approx. 0.3 bar must be maintained until the hose liner has cured. The curing times in Appendix 18 must be observed.
2. Hot curing:
   The heating hose must be connected to the heating system/unit (system 15). Subsequently, the hose liner is to be cured as described in Section 4.3.6.1 a) Item 2. by means of hot water circulation via the heating system/unit. The curing times in appendix 17 and 18 must be observed. After completion of the curing as described in Section 4.3.6.1 a) item 2, the heating water shall also be cooled to approx. +25 °C to +20 °C by adding cold tap water. A cooling phase of approx. 1 hour shall be observed and not be shorter than this. After reaching these temperature levels, the water must be drained off as described in Section 4.3.6.1 a) Item 2 and the calibration hose removed.
3. Steam curing:
   After the inversion of the calibration hose, the curing has to be carried out as described in section 4.3.6.1 a) point 3. The curing times in Annex 17 shall be observed. After curing is complete, the steam system must be switched off and the hose liner must be cooled slowly down to approx. +20 °C by adding cold air (30 minutes to 60 minutes). The calibration hose must be removed.

The curing times and temperatures as described in section 4.3.6.1 a) shall be observed.

4.3.7 Final work

After curing, the resulting inner pipe must be cut off and removed at the respective manhole wall using compressed air-operated cutting tools in the start and target manhole. In the intermediate manholes, the upper half shell of the resulting pipe must be removed until it reaches the bottom of the manhole.

The pipe sections (circular rings) for the subsequent tests shall be taken from the support pipes or support hoses which are also to be removed (see section 7).

When carrying out cutting work, the relevant accident prevention regulations must be observed.

4.3.8 Reconnection of lateral connections using top-hat profile technology

Lateral connections can be restored either in open construction or by means of renovation procedures for which general building authority approvals are valid.

4.3.9 Manhole connection

Manhole connections must be made watertight using swelling auxiliary tapes (Appendix 19), which must be positioned in the area of the manhole connections before the protective hose (PE-preliner) is drawn in.

Both in the respective start and, if applicable, also in the target manhole, as well as in the intermediate manholes, the resulting projections (see also Section 4.3.7 Final work) of the cured inner pipe to the end wall of the manhole (so-called mirror) and the transitions to the flow channel in the start and target manhole must be made watertight.

The proper design of the watertight transitions must be ensured.

In areas where swelling tapes (auxiliary tapes) cannot be used for constructional reasons, the watertight design of the connection areas between the hose liner and the manhole can also be carried out in the following way after the hose liner has cured:

a) Connection of the hose liners by means of reaction resin filler, for which a general construction approval is valid,

b) Connection of the hose liners by means of mortar systems for which a general construction supervision approval is valid,

c) GRP laminates,

d) Grouting with polyurethane (PU) or epoxy (EP) resins for which a general building authority approval is valid,

e) Installation of hose liner end sleeves for which a general construction approval is valid.

5 Marking in the manhole

The following inscription should be permanently and easily legible in the start or end manhole of the rehabilitation measure:

- Type of rehabilitation
- Designation of the line section
- Nominal diameter
- Wall thickness of the hose liner
- Year of restructuring

6 Final inspection and leak test

After completion of the work, the rehabilitated pipeline section must be visually inspected. It must be determined whether any material residues have been removed and whether there are no hydraulically disadvantageous folds.

After curing of the hose liner, including the restoration of the lateral connections, the tightness must be checked, if necessary including the manhole connection areas. This can also be done in sections.

The tightness of the renovated pipes must be tested using water method "W" or air method "L" according to DIN EN 161022 (Appendix 23). When testing with air, the specifications in Table 3 of DIN EN 161022, Test Method LD for damp concrete pipes and all other materials must be observed. The rehabilitated lateral connections can also be tested separately for water tightness using suitable shut-off plugs or shut-off discs.

7 Tests on samples taken

7.1 General information

Circular rings or segments are to be removed from the cured circular liner on site (e.g. sample accompanying sheet appendix 24). If it turns out that the test specimens are unsuitable for the tests mentioned in Section 7.2.1 or that sampling of circular rings and segments is not possible, a DSC analysis in accordance with Section 7.2.2 can be carried out alternatively for house connection liners up to DN 200.

For the investigation of the characteristic material properties by means of Differential Scanning Calorimetry (DSC), test specimens are to be taken from the attitude on the construction site. The samples are to be taken by means of core drilling. The diameter of the sample should be at least 2.5 cm.

7.2 Strength properties

7.2.1 Determination of the strength properties after 3-point bending and long-term apex pressure test

The bending modulus of elasticity and the bending stress O_{fB} must be determined on the samples taken.

For these tests, the short-term value, the 1-h value and the 24-h value of the bending modulus of elasticity and the short-term value of the bending stress o_{fB} shall be recorded. During the test it must also be determined whether the creep tendency of Kn <12% in accordance with DIN EN ISO 899-2[23] is maintained in accordance with the following relationship:

$$K_n = \frac{E_{1h} - E_{24h}}{E_{1h}} \times 100$$

In addition, the bending modulus of elasticity and the bending stress O_{fB} must be determined on the cured hose liner using the three-point method according to DIN EN ISO 11296-42 or DIN EN ISO 1787 (three-point bending test). Whereby curved test bars from the corresponding circular profile are to be used, which should have a minimum width of 50 mm in the radial direction. When testing and calculating the modulus of elasticity, the span measured between the support points of the test bar shall be considered.

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DIN EN 1610	Installation and testing of waste water pipes and sewers; German version EN 1610:2015; Edition:2015-12
DIN EN ISO 899-2	Plastics - Determination of creep behavior - Part 2: Creep rupture bending test at three-point load (ISO 899-2:2003); German version EN ISO 899-2:2003; Edition:2003-10

The short-term values determined for the bending stress $_{ofB}$ and the modulus of elasticity (1-minute values) must be equal to or greater than the values specified in section 9.

7.2.2 Determination of the strength properties by means of DSC analysis for house connection liners up to DN 200

If sampling of circular rings or segments is not possible, a DSC analysis for house connection liners up to DN 200 can alternatively be carried out on the samples taken at the construction site. For this purpose, the following test procedure must be followed:

1. Cutting through the drill core with a diamond cut
2. Measurement of the wall thickness of the supporting laminate at three points
3. Qualitative assessment of the laminate in the area of the saw cut according to DIN 18820-3[24], section 5.2
4. Removal of the sample for DSC analysis from the laminate
5. DSC analysis according to DIN 53765[25], method A-20
6. Assessment of results according to section 9

7.3 Watertightness of the samples

The water tightness of the cured hose liner can be tested either on a hose liner section (circular ring) without protective film or on test pieces taken from the cured hose liner without film coating. For the test, the film of the liner section or test piece must either be removed or perforated. The laminate must not be damaged in the process. The test on test pieces can be carried out either with positive or negative pressure of 0.5 bar. In the negative pressure test, the sample must be subjected to water on one side. At a negative pressure of 0.5 bar, no water leakage shall be visible on the unapplied side of the sample for a test period of 30 minutes. For the overpressure test, a water pressure of 0.5 bar shall be applied for 30 minutes. Again, no water leakage shall be visible on the unexposed side of the sample.

7.4 Wall construction

The wall structure in accordance with the conditions in section 2.1.2.1 shall be checked on cut surfaces, e.g. using a light microscope with a magnification of about 10 times. In addition, the average area percentage of air bubbles shall be checked in accordance with DIN EN ISO 7822[26].

7.5 Physical characteristics of the cured hose liner

The characteristic values specified in section 2.1.2.2 shall be checked on the samples taken.

DIN 18820-3	Laminates of textile-glass-reinforced unsaturated polyester and phenacrylate resins for load-bearing components (GF-UP, GF-PHA); protective measures for the load-bearing laminate
DIN 53765	; edition:1991-03
DIN EN ISO 7822	Testing of plastics and elastomers; thermal analysis; dynamic differential calorimetry (DDK); edition:1994-03
	Glass-fiber reinforced plastics - Determination of amount of void loss on ignition , mechanical decomposition and statistical methods of analysis

Declaration of conformity on the remediation measure carried out

Confirmation of the conformity of the executed refurbishment measure with the provisions of this General Building Inspectorate Approval must be provided by the executing company with a declaration of conformity based on the specifications in Tables 1 and 2. The declaration of conformity shall be accompanied by documentation on the properties of the process components according to section 2.1.1 and the results of the tests according to Table 1 and Table 2.

The head of the remediation operation or an expert representative of the head must be present on the site during the execution of the remediation. He shall ensure that the work is carried out properly in accordance with the provisions of Section 4 and in particular shall carry out or arrange for the tests in accordance with Table 1 and arrange for the tests in accordance with Table 2. The number and scope of the specifications carried out are minimum requirements.

The tests on test specimens according to Table 2 shall be carried out by an inspection body recognized by the building authorities (see list of testing, inspection and certification bodies according to the State Building Regulations, Part V, No. 9).

Once every six months, the sampling from a liner of an executed rehabilitation measure is to be carried out by the aforementioned monitoring center. This monitoring body must also check the documentation of the implementation according to Table 1 of the rehabilitation measure.

Table 1: "In-process inspections

Subject of the audit	Nature of the request	Frequency
optical inspection of the line	according to section 4.3.1 and DWA-M 149-219	before each renovation
optical inspection of the line	according to Section 6 and DWA-M 149-219	after each renovation
Equipment	according to section 4.2	every construction site
Marking of the containers of the remediation components	according to section 2.2.3	
Air or water tightness	according to section 6	
resin mixture, resin quantity and curing behaviour per hose	Mixing protocol according to section 4.3.5	
Curing temperature and curing time	according to section 4.3.6	

The inspections referred to in Table 2 shall be arranged by the head of the rehabilitation project or his expert representative. For the tests specified in Table 2, samples shall be taken from the sample tubes described.

Table 2: "Tests on specimens

Subject of the audit	Nature of the request	Frequency
Short-time bending modulus of elasticity, short-time bending stress O_{fB} and creep tendency at tube sections or at circular rings	according to sections 7.1 and 7.2	every construction site, at least every second liner
density and hardness of the sample without PE-preliner and without coating film	according to section 2.1.2.2	
Waterproofness of the sample without PE-preliner and without coating film	according to section 7.3	
Wall construction	according to section 7.4	
Short-term modulus of elasticity (short-term ring stiffness) and creep tendency at pipe sections or cut-outs	according to section 7.2	if the short-term E-module mentioned in section 9 is not reached and at least 1 x hose liner per half-year
Checking the glass transition temperature TG1 and TG2 by means of DSC analysis1 for house connection liners up to DN 200	according to sections 2.1.2.3 and 7.2.2	every construction site, at least every second liner

If compliance with the glass transition temperatures TG1 and TG2 specified in 2.1.2.3 has been demonstrated by means of DSC analysis on the samples taken at the construction site, this shall also be deemed to be proof of compliance with the physical characteristic values of the cured polyester fiber resin composite specified in 2.1.2.2.

The test results shall be recorded and evaluated; they shall be presented to the German Institute for Structural Engineering on request.

9 The number and scope of the specifications listed in the tables are minimum requirements.

Provisions for the dimensioning

If a static calculation is required for renovation measures, the stability of the structure must be verified in accordance with DWA-A 143-29 of the German Association for Water Management, Wastewater and Waste (Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e. V.) prior to execution.

In the static calculation, a partial safety factor of γ_M = 1.35 must be considered for the hose liner material.

The reduction factor A for determining the long-term value according to 10,000 h test in accordance with DIN EN 761[27] is Resin system "EasyPox 3008" A = 2.13.

The reduction factor A for determining the long-term value according to 10,000 h test in accordance with DIN EN 761[28] is Resin system "EasyPox 6024" A = 2.59.

The reduction factor A for determining the long-term value according to 10,000 h test in accordance with DIN EN 76128 is Resin system "EasyPox T0530" A = 3.20.

DIN EN 761Plastic piping systems - Glass fiber reinforced thermoset pipes
Plastics (GRP) - Determination of creep factor in dry state; German version EN 761:1994; Ausgabe: 1994-08

The following values are to be considered for the static calculation:

- Resin system "EasyPox 3008" (cold-curing resin system) with the polyester fiber hoses "ThermoLiner^{plus}" and "ThermoLiner 3.5 mm and 5.0 mm":
  - Short-time circumferential E-modulus according to DIN EN 122811: 2.820 N/mm^2
  - Long term circumferential E-modulus: 1,320 N/mm^2
  - Short-term bending stress $_{OfB}$ according to DIN EN ISO 11296-42 or DIN EN ISO 1787: 75 N/mm^2
  - Long term bending stress 35 N/mm^2
  - Reduction factor A after 10,000 h: 2,13
- Resin system "EasyPox 6024" (cold-curing resin system) with the polyester fiber hoses "ThermoLiner^{plus}" and "ThermoLiner 3.5 mm and 5.0 mm:
  - Short-time circumferential E-modulus according to DIN EN 122811: 2.650 N/mm^2
  - Long term circumferential E-module: 1.023 N/mm^2
  - Short-term bending stress O_{fB} according to DIN EN ISO 11296-42 or DIN EN ISO 1787: 55 N/mm^2
  - Long term bending stress O_{fB}: 21 N/mm^2
  - Reduction factor A after 10,000 h: 2.59

Resin system "EasyPox T0530" (thermosetting resin system) with the polyester fiber hoses "ThermoLiner^{plus}", "ThermoLiner 3.5 mm and 5.0 mm" and "ThermoLiner M":

- Short-time circumferential elastic modulus according to DIN EN 122811: 2,500 N/mm^2
- Long-term circumferential E-module: 780 N/mm^2
- Short-term bending stress O_{fB} according to DIN EN ISO 11296-42 or DIN EN ISO 178: 50 N/mm^2

Long term bending stress O_{fB}: 16 N/mm^2
Reduction factor A after 10,000 h: 3,20

Rudolf Kersten
Head of Unit

Beglaubigt
Deutsches Institut für Bautechnik

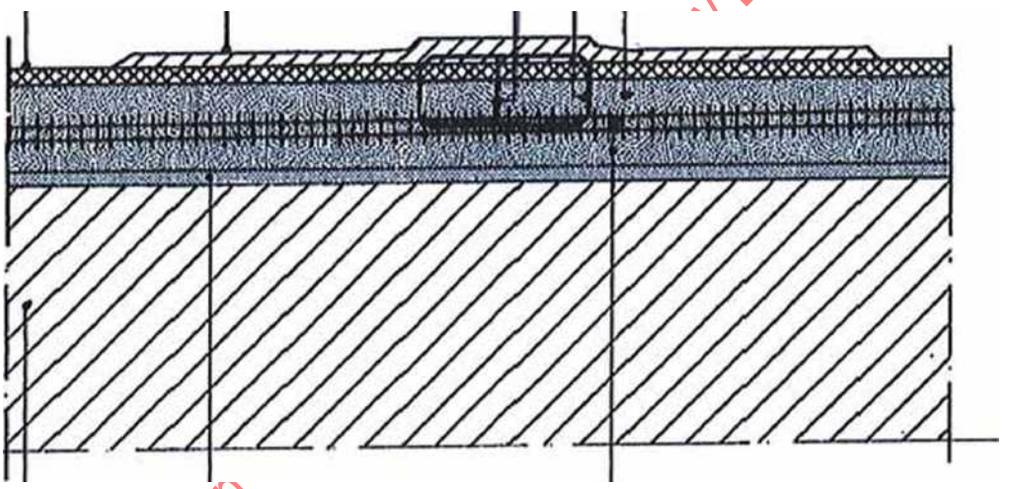
Schematic structure of ThermoLiner^{plus}, ThermoLiner and ThermoLiner M

-foil coating

-seam cover

-butt seam **[ThermoLiner / Thermoliner M]. -**
Thread **(ThermoLiner plus)**

- Polyester needle felt with butt joint



-old pipe

-PE- foil/PE-preliner

-Polyester needle felt with/without

The "EasyLiner" hose lining method for the rehabilitation of underground wastewater pipes in the nominal width range from DN 100 to DN 600

Appendix 1

Structure of ThermoLiner^{plus}, ThermoLiner, ThermoLiner M

Features	ThermoLiner^{plus}	ThermoLiner 3,5 and 5,0	ThermoLiner M
Support material	Polyester needle felt	Polyester needle felt	Polyester needle felt
Coating	approx. 260 µm	approx. 350 µm	approx. 400 µm
Temperature resistance	max. 80° C	max. 80° C	max. 100° C
Nominal sizes	DN 100-300	DN 100-300	DN 150-600
Felt thickness	approx. 5,0 mm	approx. 3,5 mm approx. 5,0 mm	from 5,5 mm to 12,0 mm
Expected final thickness	>3.0 mm	>3.0 mm >4.5 mm	from 4,5 mm to 10,5 mm
Seam connection	sewn and sealed	sewn and sealed	welded and sealed
Suitability	Cold and hot curing	Cold and hot curing	Artificial ageing
Arcing	Very good, up to 90° almost wrinkle-free	conditional, up to 45°	conditionally
Resin systems	Easy Pox 3008 Easy Pox 6024 Easy Pox T0530	Easy Pox 3008 Easy Pox 6024 Easy Pox T0530	Easy Pox T0530

Hose lining method with the designation "EasyLiner" for the rehabilitation of underground sewer pipes in the nominal width range from DN 100 to DN 600	Appendix 2
Technical data sheet - ThermoLiner plus, ThermoLiner 3.5 and 5.0 and Thermoliner M	

Ring stiffness DN 100-DN 300

The following short-time modulus of elasticity value was used as a basis for calculating the stiffness:

Resin 3008: 2,820 MPa

The minimum wall thickness of the cured liner was set at 3.0 mm and 4.5 mm.
These values result in the following stiffness tables:

Resin 3008: Calculated values

	SN In N/m²		Wall thicknesses
	3,0	4,5	
DN			
100	6.950	24.600	
125	3.490	12.200	
150	2.000	6.950	
200	830	2.870	
225	580	2.000	
250	421	1.450	
300	242	830	

Resin 3008: rounded to existing stiffness classes

	SN in N/m²		Wall thickness
	3,0	4,5	s in mm
DN			
100	5.000	>10.000	
125	2.500	>10.000	
150	1.250	5.000	
200	830	2.500	
225	500	1.250	
250		1.250	
300		830	

Hose lining method with the designation "EasyLiner" for the rehabilitation of underground sewer pipes in the nominal width range from DN 100 to DN 600

Appendix 3

Ring stiffness DN 100 mm to DN 300 mm

Ring stiffness DN100-DN 300

The following short-time modulus of elasticity value was used as a basis for calculating the stiffness:

Resin 6024: 2,650 MPa

The minimum wall thickness of the cured liner was set at 3.0 mm and 4.5 mm.
These values result in the following stiffness tables:

Resin 6024: Calculated values

	SN in N/m²		Wall thickness s
	3,0	4,5	
DN			
100	6.530	23.100	
125	3.280	11.500	
150	1.880	6.530	
200	780	2.690	
225	545	1.880	
250	396	1.360	
300	228	780	

Resin 6024: rounded to existing stiffness classes

	SN in N/m²		Wall thickness
	3,0	4,5	s in mm
DN			
100	5.000	10.000	
125	2.500	10.000	
150	1.250	5.000	
200	500	2.500	
225	500	1.250	
250	-	1.250	
300	-	500	

Ring stiffness
DN 100 - DN 600

The following short-time modulus of elasticity value was used as a basis for calculating the stiffness:

Resin T0530: 2,500 MPa

The minimum wall thickness of the cured liner was set at 3.0 mm -10.5 mm.
These values result in the following stiffness tables:

Resin T 0530: Calculated values (rounded off)

		SN in N/m²					Wall thickness s
	3,0	4,5	6,0	7,5	9,0	10,5	
DN							
100	6.100	21.700	54.000	111.000	201.000	336.400	
125	3.000	10.800	26.700	54.100	97.300	160.600	
150	1.700	6.100	15.000	30.300	54.100	88.800	
200	700	2.500	6.100	12.300	21.700	35.400	
225	500	1.700	4.200	8.500	15.000	24.400	
250	350	1.200	3.000	6.100	10.800	17.500	
300	200	700	1.750	3.500	6.150	9.900	
400	90	300	700	1.450	2.500	4.050	
500	50	150	350	700	1.250	2.050	
600	30	90	200	400	700	1.150	

Resin quantity required:

Easy Pox

ThermoLiner^{plus} and ThermoLiner 3.5 and 5.0

DN	Quantity of resin ThermoLiner^{plus} per meter in kg liner 5.0 mm	Resin quantity ThermoLiner 3.5 / 5.0 per meter in kg Liner 3.5 mm / Liner 5.0 mm
100	1,40	1,051 ,45
125	1,65	1,251 ,65
150	2,20	1,572 ,20
200	2,75	2,002 ,70
225	3,29	3,20
250	3,65	3,55
300	4,41	4,30

The consumption quantities are independent of the Easy Pox resin type.
The stated resin quantities refer to the impregnation.
Density Easy Pox: 1,13 g / cm3
(components A + B)

Hose lining method with the designation "EasyLiner" for the rehabilitation of underground sewer pipes in the nominal width range from DN 100 to DN 600

Resin quantity table ThermoLiner plus and ThermoLiner 3.5 and 5.0

Annex 6

Resin quantity required Thermoliner M in kg/m

Felt thickness in delivery condition in [mm]	5,5	7,0	8,5	11,0	12,0
Distance between rollers on the impregnation table in [mm].	11	14	17	22	24
DN					
150	2,28	2,90	3,53	4,56	4,98
200	3,04	3,87	4,70	6,08	6,64
250	3,80	4,84	5,88	7,60	8,30
300	4,56	5,81	7,05	9,13	9,96
350	5,32	6,78	8,23	10,65	11,61
400	6,08	7,74	9,40	12,17	13,27
450	6,84	8,71	10,58	13,69	14,93
500	7,60	9,68	11,75	15,21	16,59
550	8,37	10,65	12,93	16,73	18,25
600	9,13	11,61	14,10	18,25	19,91

Resin quantity required Thermoliner M in l/lfm

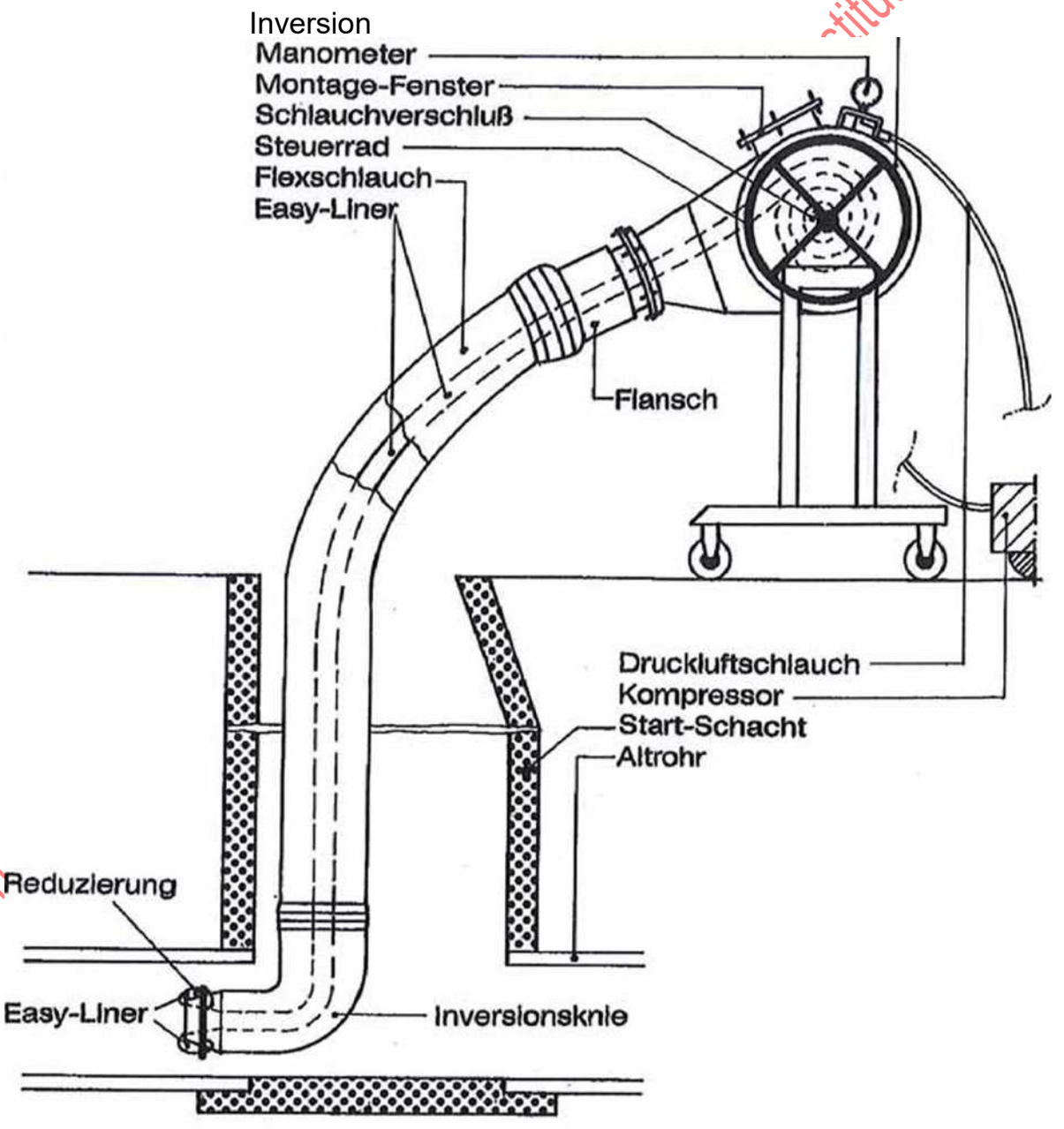
Felt thickness in delivery condition in [mm]	5,5	7,0	8,5	11,0	12,0
Distance between rollers on the impregnation table in [mm].	11	14	17	22	24
DN					
150	2,02	2,57	3,12	4,04	4,41
200	2,69	3,43	4,16	5,38	5,87
250	3,37	4,28	5,20	6,73	7,34
300	4,04	5,14	6,24	8,08	8,81
350	4,71	6,00	7,28	9,42	10,28
400	5,38	6,85	8,32	10,77	11,75
450	6,06	7,71	9,36	12,11	13,22
500	6,73	8,57	10,40	13,46	14,68
550	7,40	9,42	11,44	14,81	16,15
600	8,08	10,28	12,48	16,15	17,62

Hose lining method with the designation "EasyLiner" for the rehabilitation of underground sewer pipes in the nominal width range from DN 100 to DN 600

Annex 7

Resin quantity table ThermoLiner M

Inversion drum
Inversion process

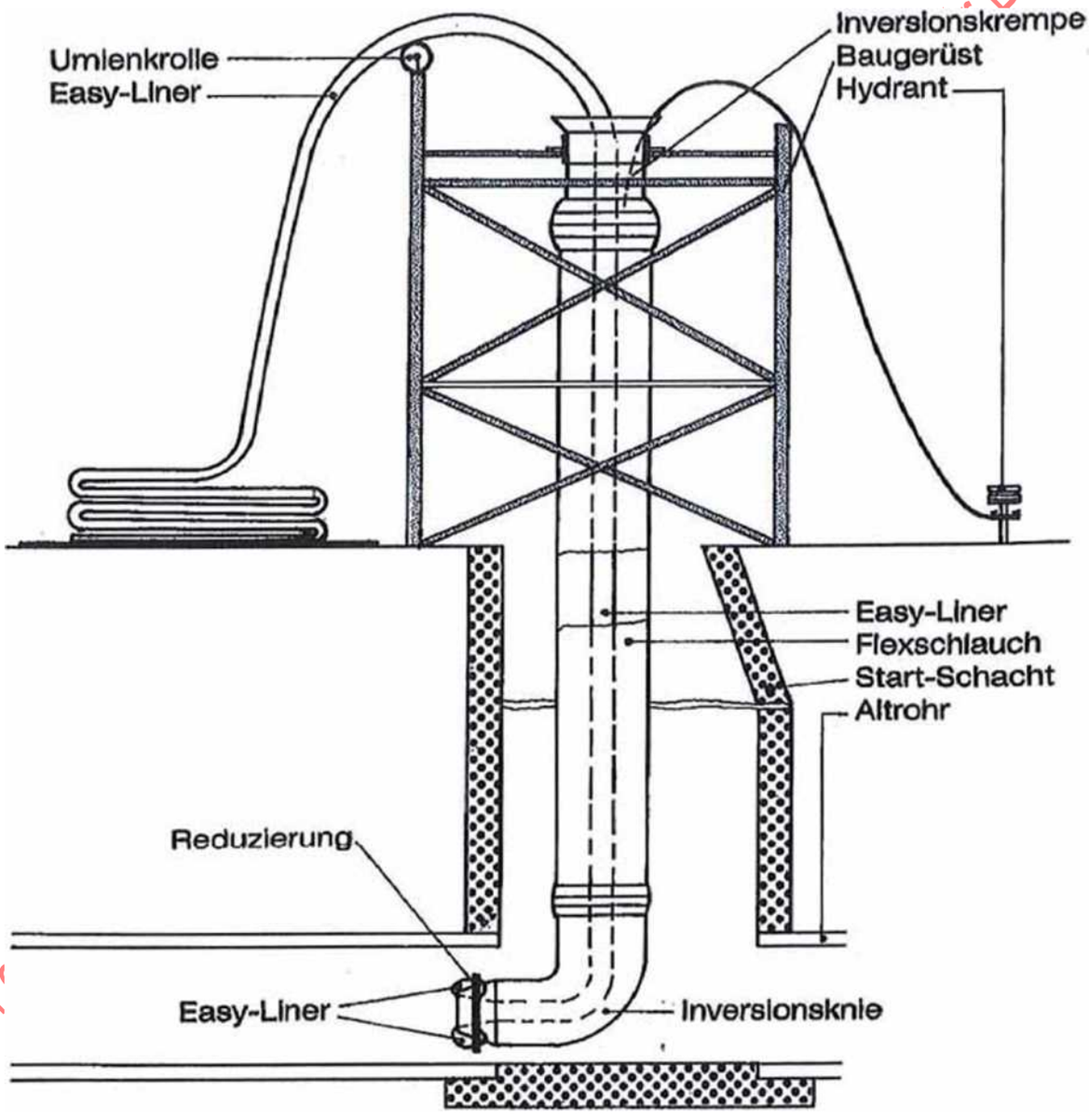


Hose lining method with the designation "EasyLiner" for the rehabilitation of underground sewer pipes in the nominal width range from DN 100 to DN 600

Annex 8

Inversion by means of compressed air

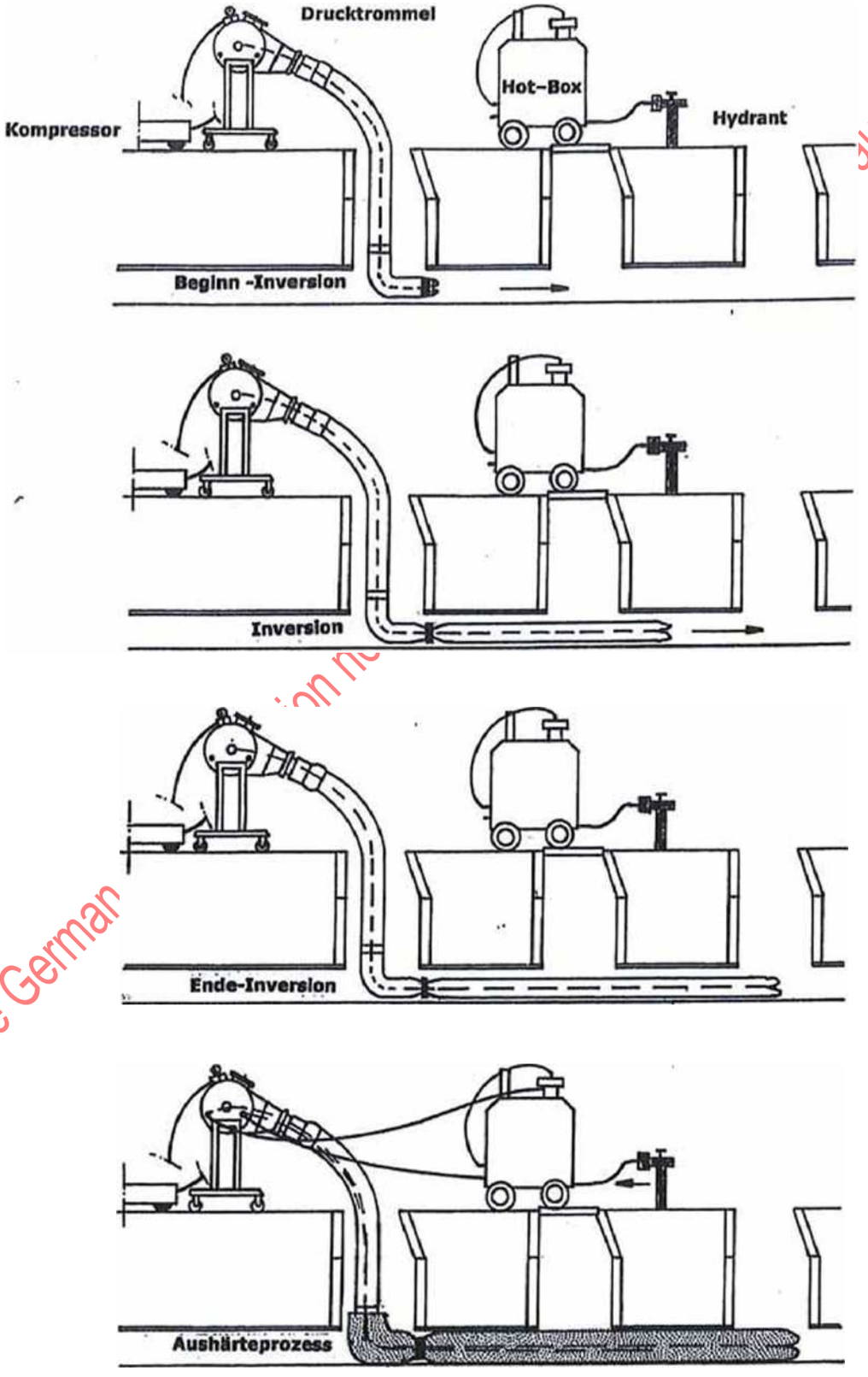
Scaffolding inversion process



Hose lining method with the designation "EasyLiner" for the rehabilitation of underground sewer pipes in the nominal width range from DN 100 to DN 600

Annex 9

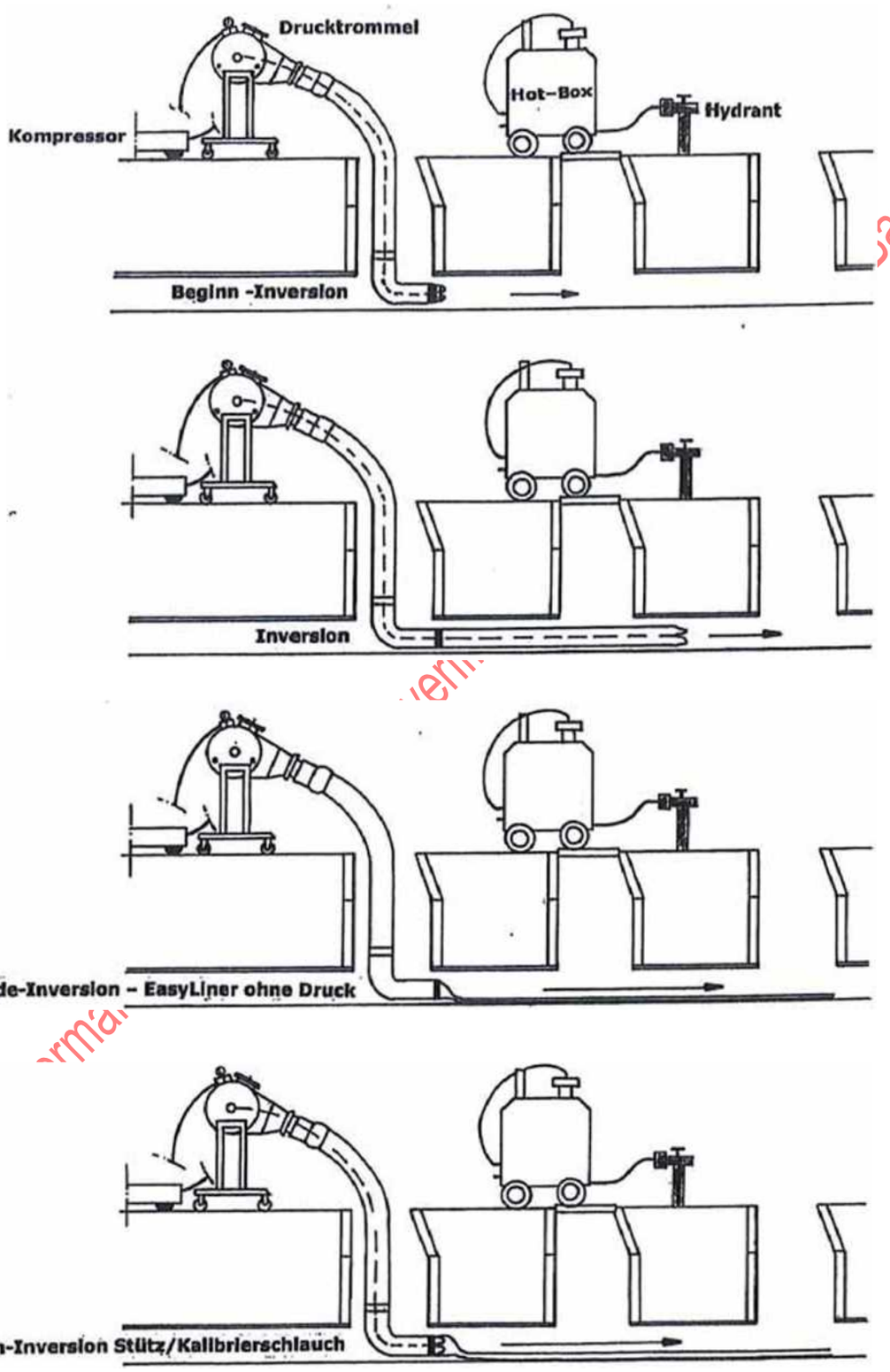
Inversion with water



Hose lining method with the designation "EasyLiner" for the rehabilitation of underground sewer pipes in the nominal width range from DN 100 to DN 600

Annex 10

Rehabilitation with closed end

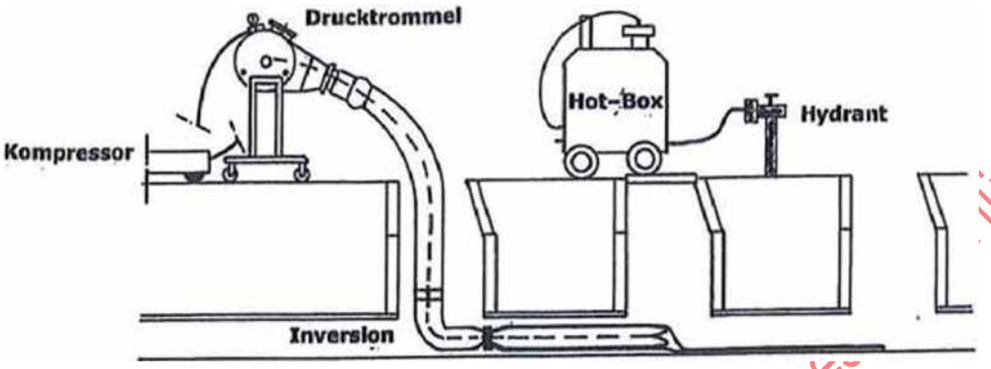


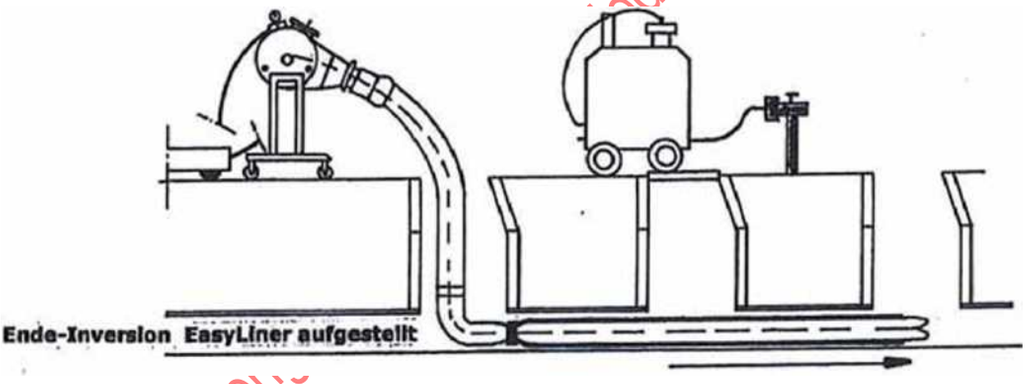
Hose lining method with the designation "EasyLiner" for the rehabilitation of underground sewer pipes in the nominal width range from DN 100 to DN 600

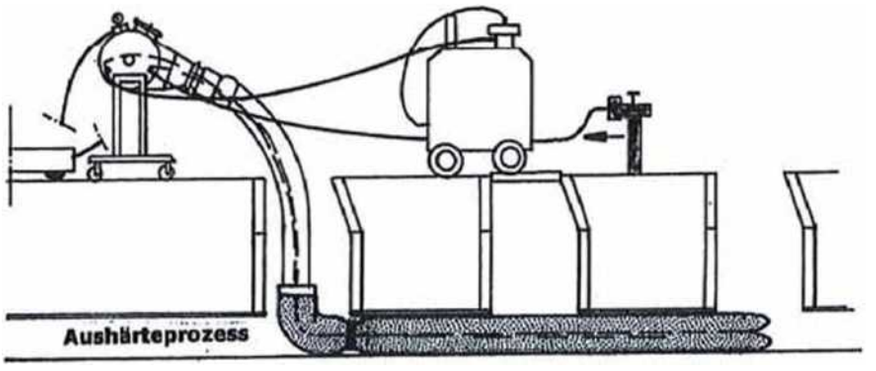
Annex 11

Rehabilitation middle open end - support/calibration hose subsequently inverted

Page 1/2



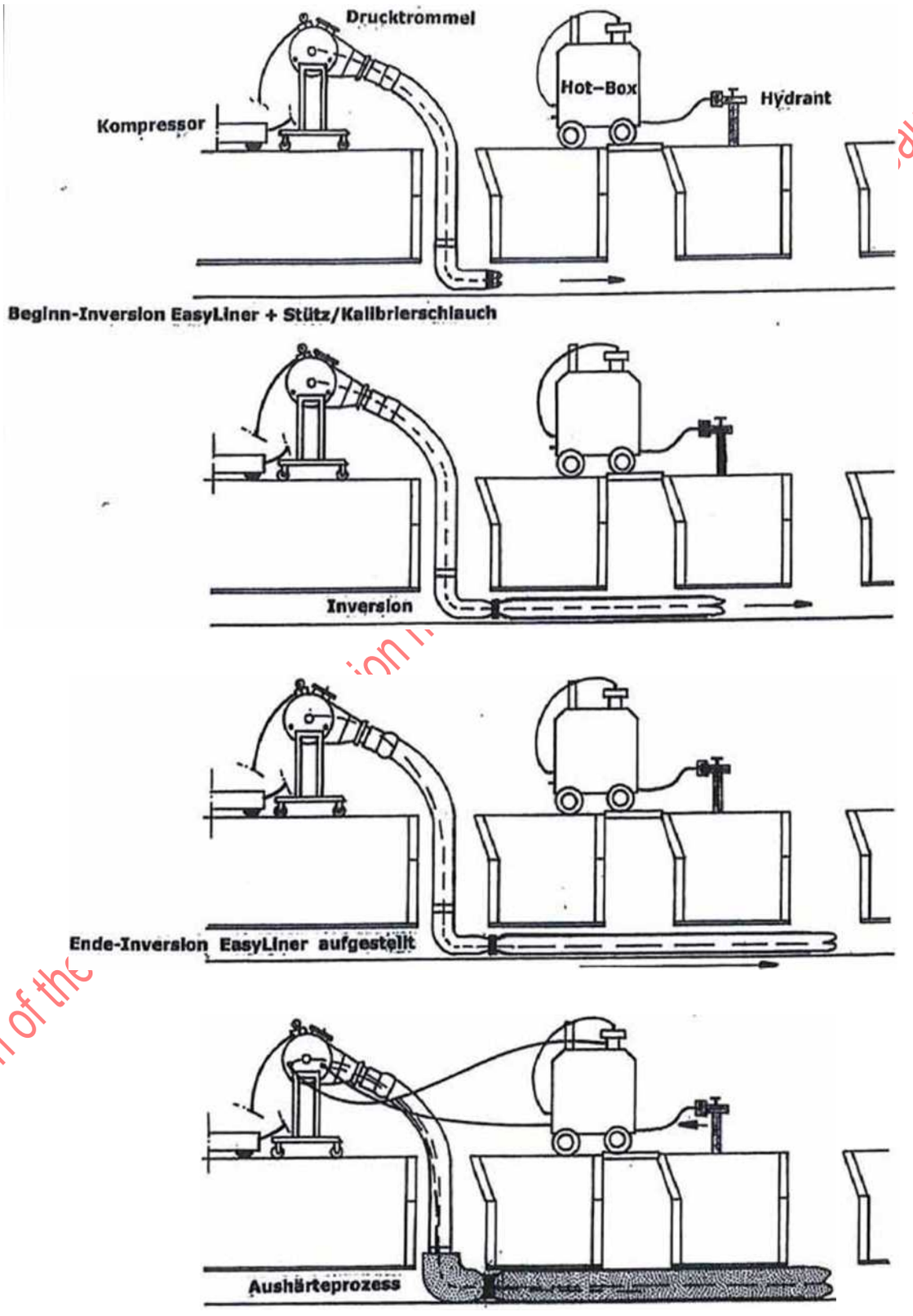




Hose lining method with the designation "EasyLiner" for the rehabilitation of underground sewer pipes in the nominal width range from DN 100 to DN 600

Annex 12

Renovation medium open end - support/calibration hose subsequently invertedPage 2/2

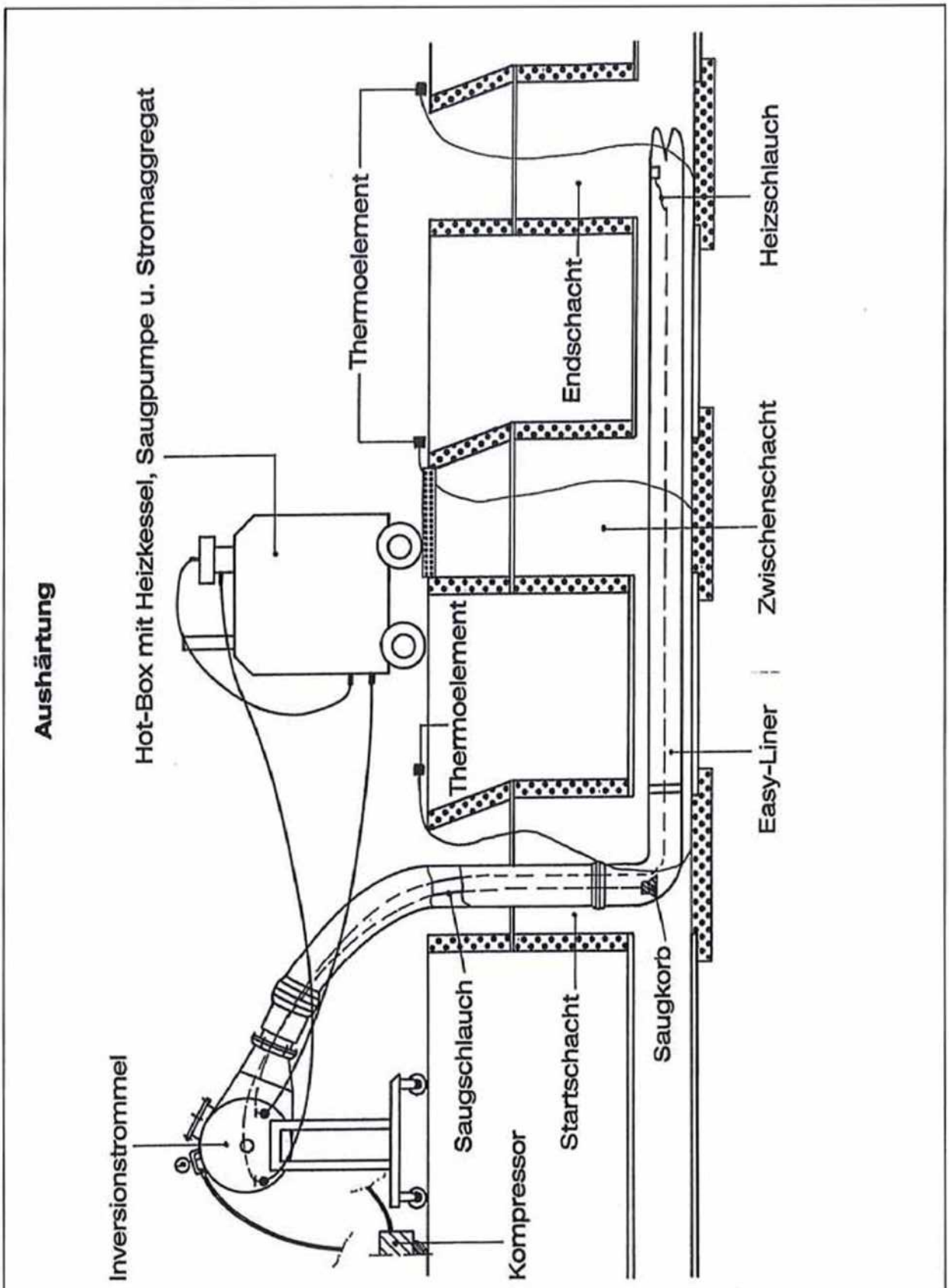


Hose lining method with the designation "EasyLiner" for the rehabilitation of underground sewer pipes in the nominal width range from DN 100 to DN 600

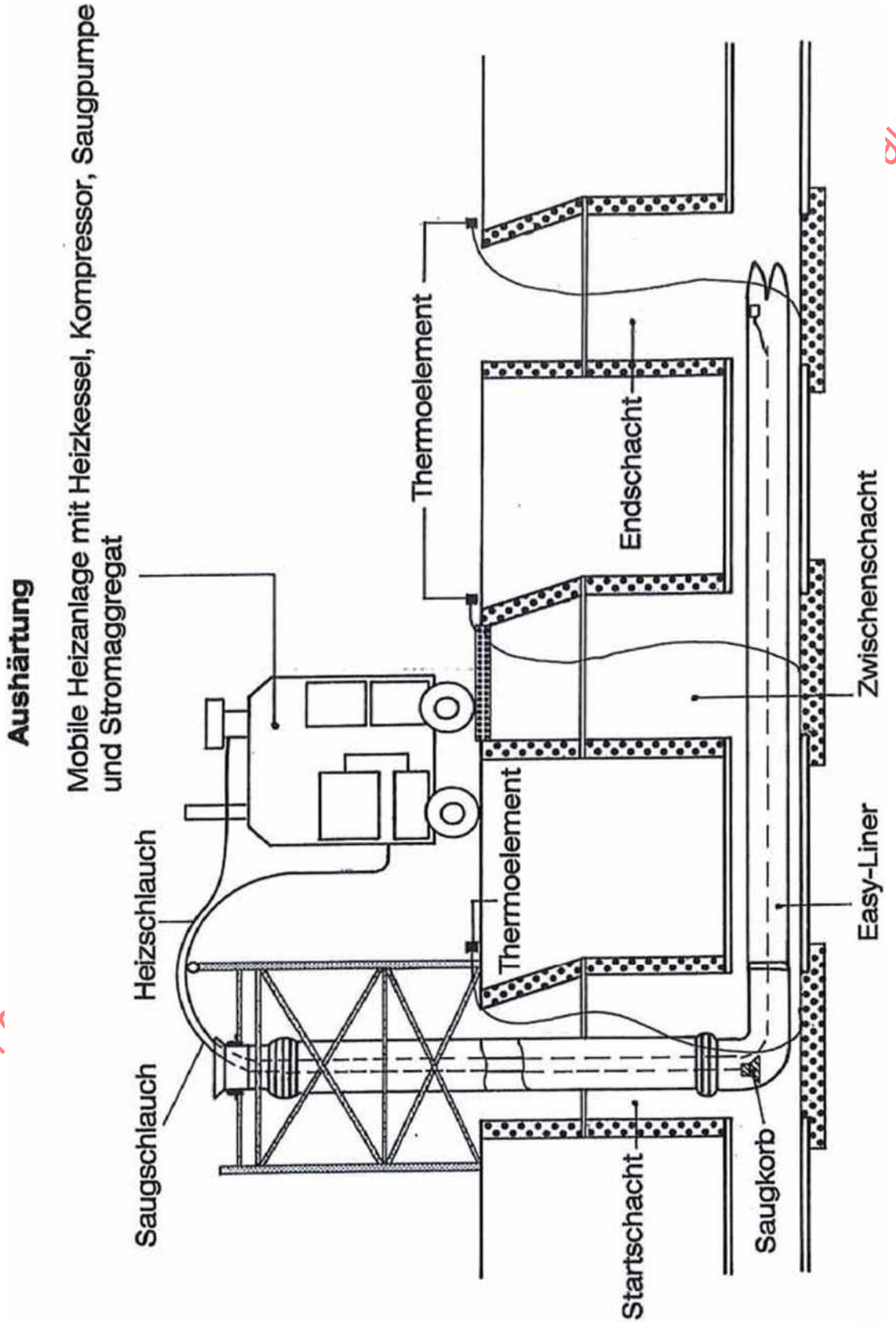
Annex 13

Medium open-end rehabilitation - support/calibration hose in one operation

Deutsches Institut für Bautechnik DIBt



Schlauchliningverfahren mit der Bezeichnung "EasyLiner" zur Sanierung von erdverlegten Abwasserleitungen im Nennweitenbereich von DN 100 bis DN 600	Anlage 14
Warmhärtung - Hotbox	

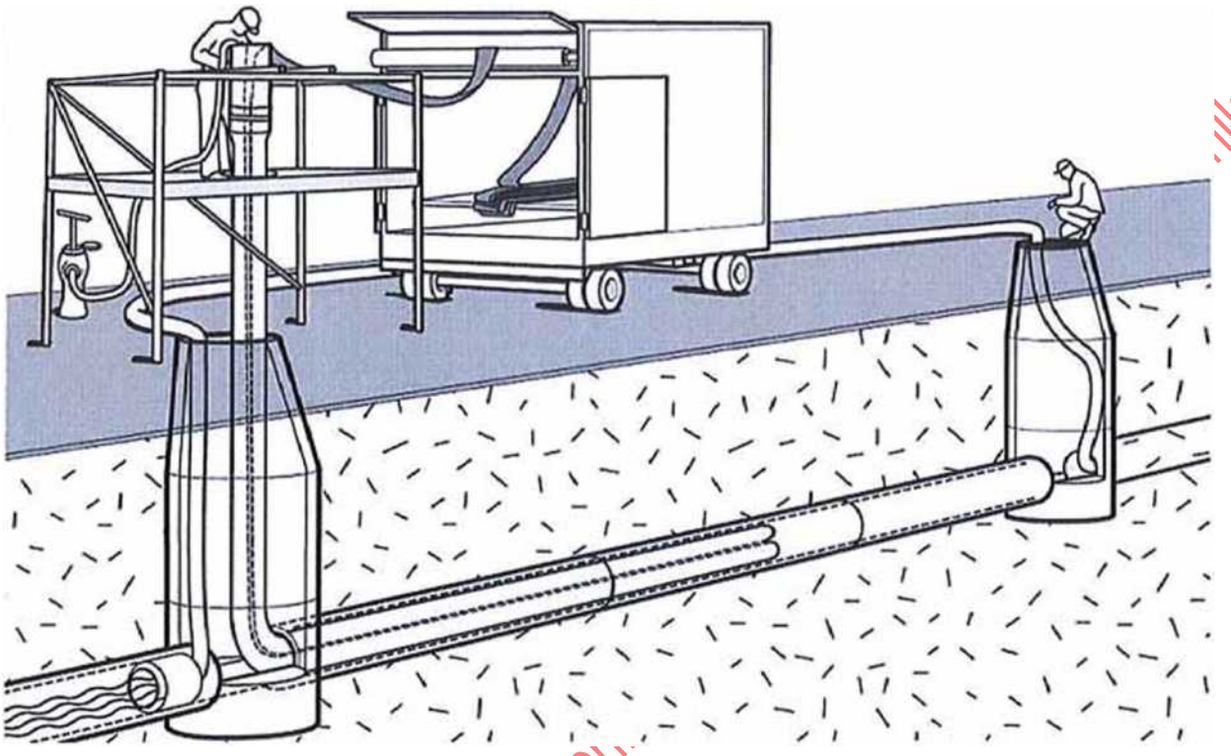


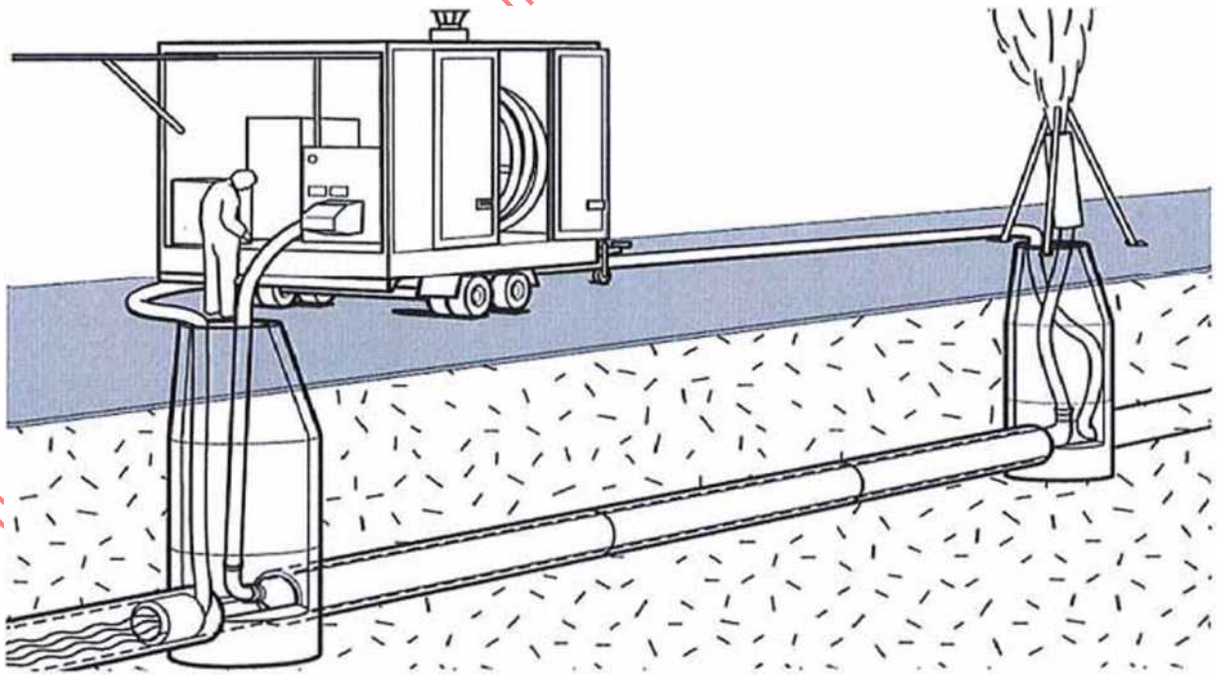
Hose lining method with the designation "EasyLiner" for the rehabilitation of underground sewer pipes in the nominal width range from DN 100 to DN 600

Annex 15

Heat curing - Mobile heating system

Structure steam technology



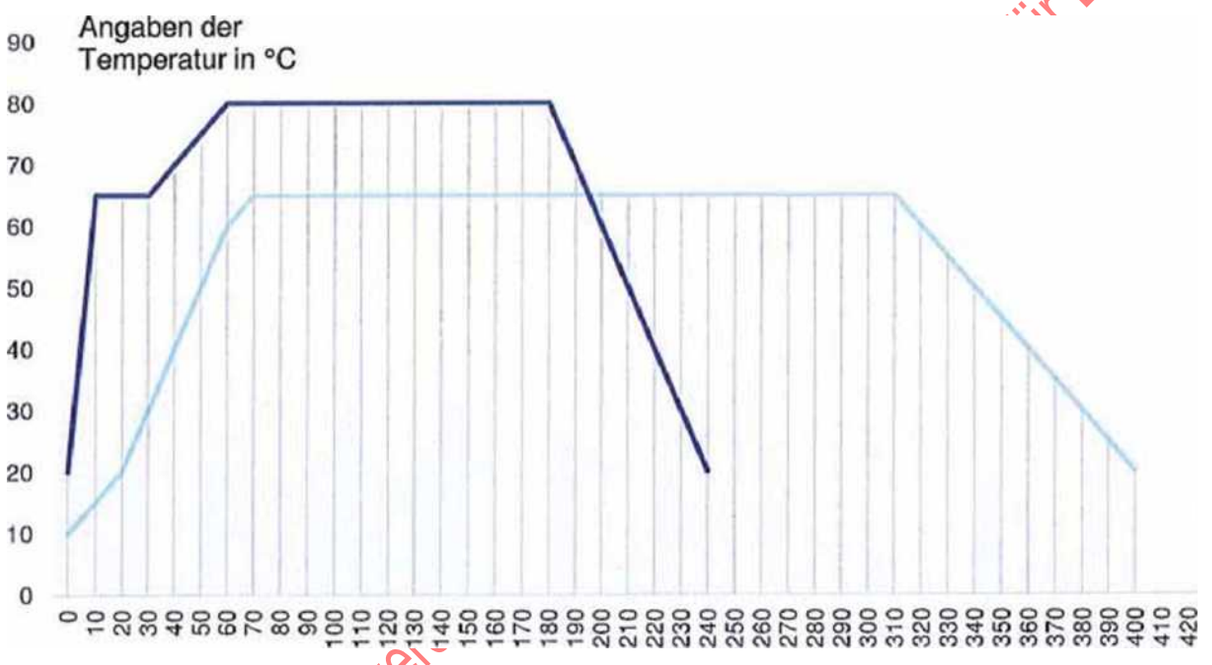


The "EasyLiner" hose lining method for the rehabilitation of underground wastewater pipes in the nominal width range from DN 100 to DN 600

Annex 16

Heat curing - steam technology

Curing curve hot water and steam for theEasy Pox T0530



Hot water (Temp. determined between old pipe and liner)

----- Steam (Temp. determined at steam outlet)

The values given in this diagram are based on experience and at continuously given heat. It is recommended to check the curing condition of the hose liner before removing the calibration pressure. The temperature conditions on the construction site have a significant influence on the curing time for the hose liner. For this reason, the above values can only provide indications.

The "EasyLiner" hose lining method for the rehabilitation of underground wastewater pipes in the nominal width range from DN 100 to DN 600

Annex 17

Heat curing - Curing curves steam and hot water

Curing table for Easy Pox resin systems

Resin type	Mix	Temperature [between old pipe and liner]	Return [Heating]	Curing time
3008	100:25	>60°C	>75°C	> 30 min.
		> 50°C	>65°C	> 60 min.
		Ambient curing under Ambient temperatures (approx. 10°C)		> 8 hours
6024	100:25	>60°C	>75°C	> 60 min.
		>50°C	>65°C	> 120 min.
		Ambient curing under Ambient temperatures (approx. 10°C)		> 24 hours
T0530	100:30	>60°C	>75°C	> 4 hours
		>50°C	>65°C	> 8 hours

The values mentioned are the pure hardness time. The time needed to bring the tent to temperature and the cooling phase are not considered. The data mentioned in the table are based on experience values with continuous heat supply. The concrete temperature conditions caused by ground water, pipe material, outside temperatures must also be considered.

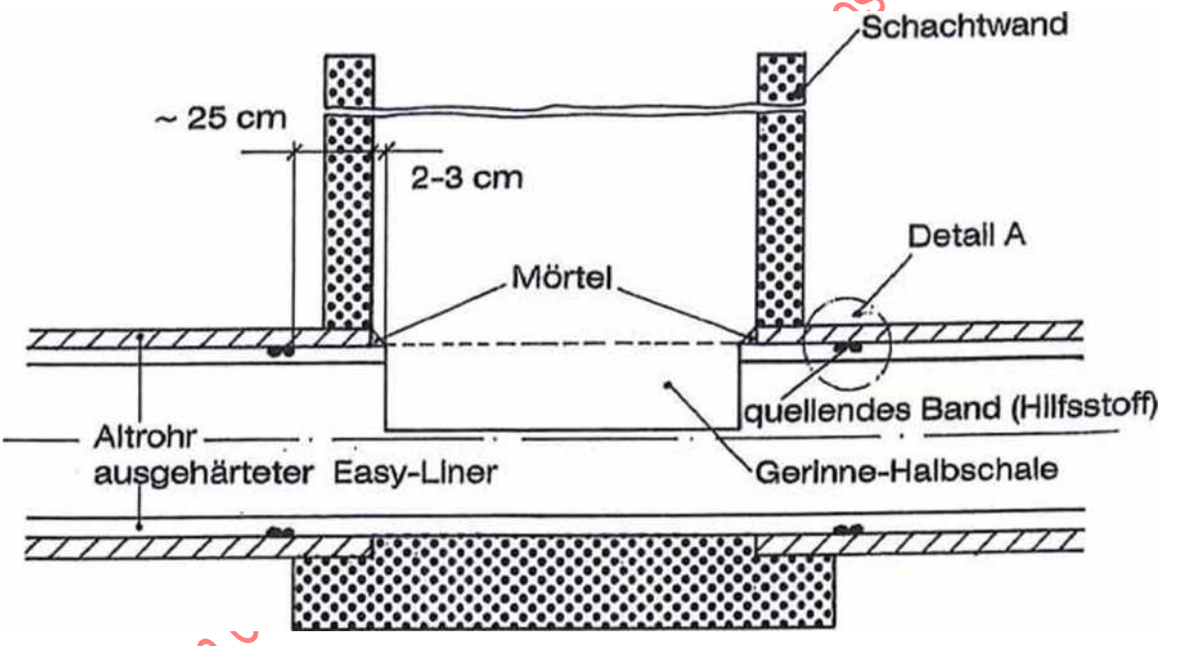
Curing table Easy Pox Systems

The "EasyLiner" hose lining method for the rehabilitation of underground wastewater pipes in the nominal width range from DN 100 to DN 600

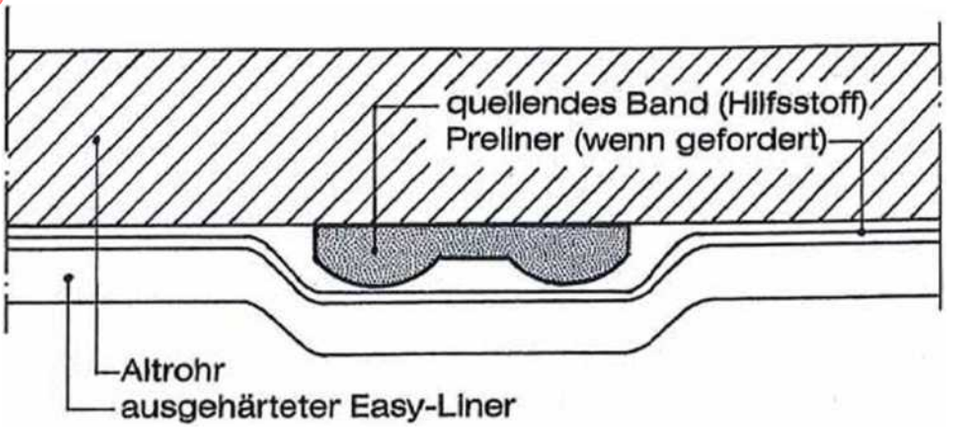
Curing times at constant ambient temperature

Annex 18

Intermediate manhole



Detail A



The "EasyLiner" hose lining method for the rehabilitation of underground wastewater pipes in the nominal width range from DN 100 to DN 600

Annex 19

Manhole connection

Production protocol hose liner part 1:

Restoration vehicle: Date: Construction site no.
Construction projects: _____
Street: _____
Client: _____

Refurbishment No.: _____
from manhole: to manhole:

Profile shape: Circle O DN Length liner:
Details of the liner type:
ThermoLiner plus O
ThermoLiner 3.5 / 5.0 O
ThermoLiner M O
Wall thickness of liner base material:
Batch number Liner:
Expected end wall thickness of liner:
Information on the epoxy resin system "Easy Pox 3003, 6024, T0530":

	Easy Pox 3008	**Easy Pox 6024**	**Easy Pox T0530**
mixture:	100:25	100:25	100:30
Pot life:	20-30 minutes	50-60 minutes	approx. 5 hours

Total material consumption: kg / lfm (according to table resin consumption)
Quantity of component A: target value (kg): actual value:(kg)
Quantity of component B: target value (kg): actual value:(kg)
Batch component A:
Batch component B:
Shelf life component A (max. 12 months): ACTUAL ORDER: Yes O No O
Shelf life component B (max.12 months): ACTUAL All right : Yes O No O

Mixing time for manual mixing:
Should be at least 3 minutes. actual value:minutes

Vacuum for hose venting:
Set point: 0.3-0.5 bar actual value:(bar)

Roller distance at the impregnation table:
Target: 2x felt wall thickness (see liner imprint), ACTUAL:(mm)

production conditions:
Ambient temperature: °C
Storage temperature maintained? Target: Frost-free - OK: Yes O No O
Resin Temperature: Target: 13-18°C actual value:°C
Hardener temperature: Target: 13-18°C actual value:°C

Hose lining method with the designation "EasyLiner" for the rehabilitation of underground sewer pipes in the nominal width range from DN 100 to DN 600	Annex 20
Manufacturer's protocol part 1	

Production protocol hose liner part 2:

Inversion procedure:
open end: O closed end: O
with bends: O without: O gradient: O
Inversion pressure or calibration pressure:
Pressure during curing: Target: 0.3-0.5 bar actual value:
Water column: O Height of the water column :m

Groundwater?	O Yes O No
PE-preliner inverted?	O Yes O No
calibration hose used?	O Yes O No

Hardening process:
Hot water: O Steam: O

Heating phase from clock to clock
Heating phase from clock to clock
Cooling phase from clock to clock
Hardening according to manufacturer's specifications observed? Yes O No O

Preparatory measures:

HD cleaning performed?	Yes O No O
Pre-sealing in posture necessary?	Yes O No O
Sewage free?	Yes O No O
Milling work necessary? TV inspection performed?	Yes O No O Yes O No O

Theses:

TV carried out after renovation?	Yes O No O
Leak test performed?	Yes O No O

Sample collection:
From manhole number:
From support tube or wall cut-out:

Comment:

Signature of responsible foreman: Date:

The "EasyLiner" hose lining method for the rehabilitation of underground wastewater pipes in the nominal width range from DN 100 to DN 600

Annex 21

Manufacturer's protocol part 2

Restoration vehicle: Date: Construction site no.
Construction projects:______________________________
Street:______________________________
Client:______________________________
Refurbishment No.: ______________________________
from manhole: to manhole:

Outdoor temperature: °C

Time:	Forward:	Return:	Measuring	Measuring point
	°C	°C	°C	°C
	°C	°C	°C	°C
	°C	°C	°C	°C
	°C	°C	°C	°C
	°C	°C	°C	°C
	°C	°C	°C	°C
	°C	°C	°C	°C
	°C	°C	°C	°C
	°C	°C	°C	°C
	°C	°C	°C	°C
	°C	°C	°C	°C
	°C	°C	°C	°C
	°C	°C	°C	°C
	°C	°C	°C	°C
	°C	°C	°C	°C
	°C	°C	°C	°C
	°C	°C	°C	°C

Remarks:

Signature of responsible foreman: Date: ____________

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Temperature - hardening process

Annex 22

PROTOCOL FOR SHEET TESTING OF WASTEWATER PIPES
based on DIN EN 1610

1. details of the construction project:

Project:			
Address:		ZIP/ location	
Client:			
Address:		ZIP/ location	
Company:			
Address:			
Manufacturer type:	O Hose liner OKurzliner	Product designation:	
Tightness test:			
Address:		ZIP/ location	

2. details of the sewer/pipeline:

Type of sewage:	O Wastewater	O Rainwater	O Mixed water
Pipe geometry	O Circular profile	O Egg-profile	
Liner material:		DN size:	Remediation date:
Posture number:			
Posture long:			
of manhole:		to manhole:	

3. leak test with air:

Test method:	OLAOLBOLGOLD		
Test pressure p_0:	mbar	Sedation time:	mbar
Press. drop Δp:	mbar	Test duration:	mbar
Pressure at the beginning: Pressure at the end:	mbar mbar	Pressure drop:	mbar

4. leak test with water:

O only pipelines	O Manholes and inspection openings	O Pipeline with manhole
Test duration:		30 min
High of the water column above the pipe apex at the beginning of the test:		kPa (= mWS * 10)
Water addition:		l
Addition of water / holding length:		l/m²
Permissible water addition per m2 of wetted area according to DIN EN 1610:		0,15 l/m²
Calculated permissible total water addition in relation to the test track:		l
actual water addition:		l

5. result

Test passed:	O yes	O no	
Remarks:			
Place / Dalum:		Signature:	

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Annex 23

Sample accompanying document for water tightness

ACCOMPANYING DOCUMENT FOR MATERIAL TESTING OF HOSE LINERS

O INITIAL TEST O REVIEW TEST for Test Report No: _____

1. information on sampling:

Taken by: _____ Testing Institute: _____

Date: _____ Time: _____ Address: _____

2. sample identification:

Construction projects:		Material ID:			
Building owner.		Sample identification:			
Cost center:		Posture description:			
Executing company:		Nominal size:			
Manufacturer hose liner:		Installation date:			
Carrier material:		Old pipe condition	O I	O II	O III
Resin material.		Extraction point:	O Line	O End	O Manhole
Tube geometry:	O circular profile O oval profile	Removal position:	O Crown	O Impost	O Sole

3. required short-term properties according to static proof:

		circumferential modulus of elasticity E_{EU}	
Bending stress at the first break σ_{fB} [N/mm]:		Initial ring stiffness S_o [N/m²]:	
Wall thickness d [mm]		max. creep tendency K_{N24} [%]:	
Reduction factor A_L		Density δ [g/cm];	

4. test results:

Bending E-modulus DIN EN ISO 178 / DIN EN ISO 11296-4 24 h creep creep According to DIN EN ISO 899-2

Test date	Ef [N/mm²]	Ors [N/mm²]	h [mm]	Inspection date K_N [%]
	Test direction:	O axial	O radial	

Circumferential E-module 24 h creep creep According to DIN EN 781

Test date	E_{EU} [N/mm2]	S0 [N/m2]	h [mm]	Inspection date K_N [%]

Watertight according to DIN EN 1810

□	Test date	Test Duty	Test pressure [bar]	Test result
		30 minutes	O tight|	O leaky|

Calcification process according to DIN EN ISO 1172

□	Test date [%]	Total arrears [%]	Glass content [%]	Aggregate [%]

Spectral analysis in to ASTM D 5576 (FT-IR) Density according to DIN EN ISO 1181-1 or -2 Test date δ [g/cm3].

Test date EP resin	UP resin	PU resin	otherwise. Resin

Thermal analysis according to DIN EN ISO 11367-1 /DSC analysis DIN 63765 method A

□	Test date	Glass transition temperature [°C]		Enthalpy [J/g]	
		T_{G1}	Δ		
		T_{G2}	Δ	O exotherm	O endotherm

residual styrene content according to DIN 63394-2 (GC)

Test date	Weighing [mg]	residual styrene	residual styrene [%]	Weighing related to	
				O Total weight	O Pure resin

5. evaluation of the results:

Requirements	fulfilled	unsatisfied
Bending-E-module E_f	O	O
Bending stress σ_{fB}	O	O
Wall thickness d	O	O
Watertightness	O	O

Requirements	fulfilled	unsatisfied
Circumferential E-modulus E_{EU}	O	O
Initial ring stiffness S_o	O	O
24 h creep K_N	O	O
density δ	O	O

6. remarks:

7. signature inspector / laboratory:

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Annex 24

Sample submission form for material testing