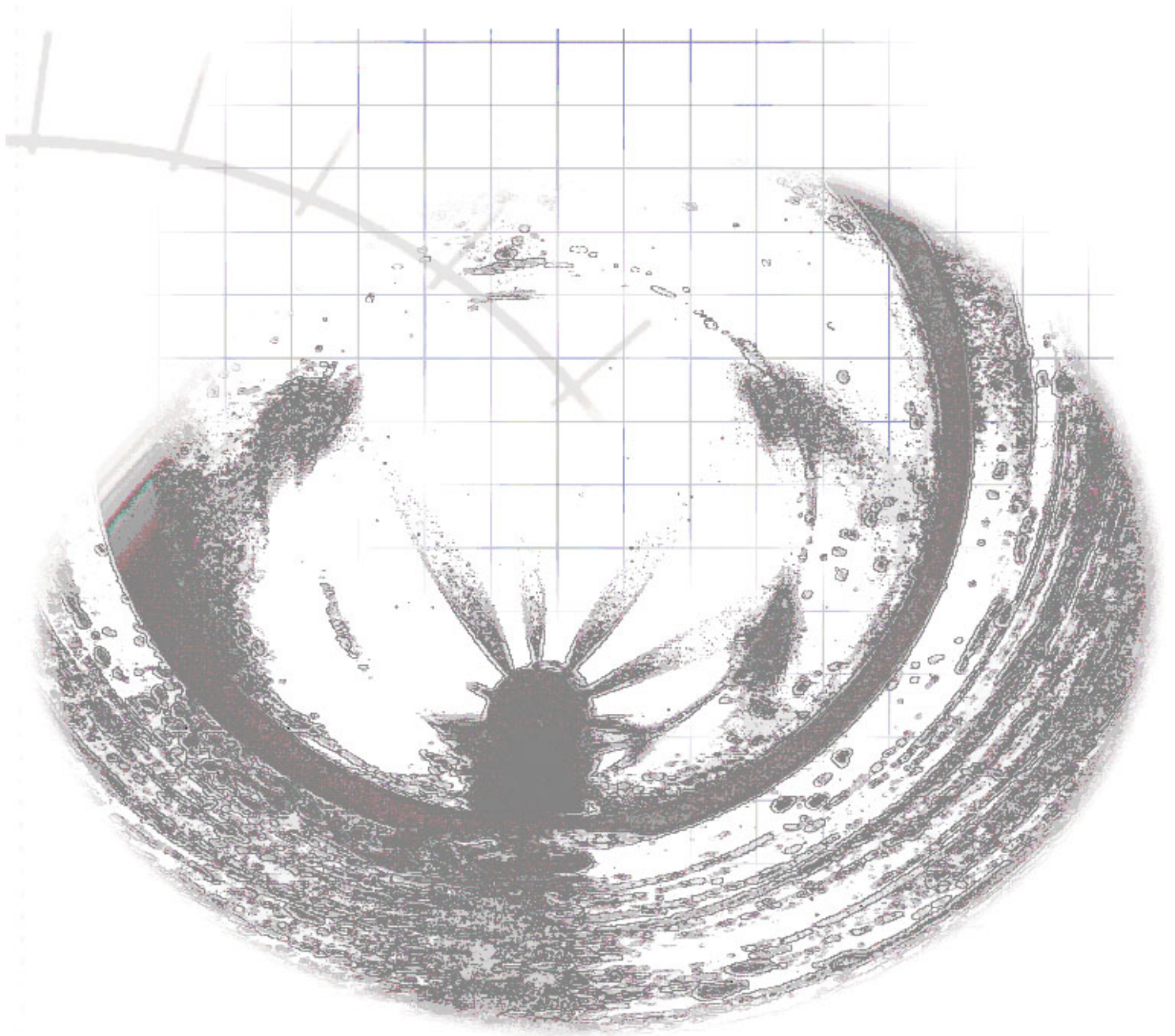




Manual EasyLiner system



1 Table of contents

2	SCOPE OF APPLICATION	2-4
3	REQUIREMENTS	3-4
3.1	GENERAL INFORMATION	3-4
3.2	QUALIFICATION OF THE COMPANY.....	3-4
3.3	MATERIALS USED.....	3-5
3.3.1	<i>Components / Structure</i>	<i>3-5</i>
3.3.2	<i>Materials</i>	<i>3-5</i>
3.3.3	<i>Resin system / EasyPox resin systems</i>	<i>3-5</i>
3.4	IMPREGNATION ON THE CONSTRUCTION SITE.....	3-5
3.5	STATIC PROOF.....	3-7
3.6	CONSTRUCTIONAL REQUIREMENTS / AREAS OF APPLICATION	3-7
3.6.1	<i>Integration in the shaft area</i>	<i>3-7</i>
3.6.2	<i>Integration in the main channel.....</i>	<i>3-7</i>
3.6.3	<i>Integration Inspection opening</i>	<i>3-7</i>
3.6.4	<i>Connection of connecting lines.....</i>	<i>3-7</i>
3.7	REQUIREMENTS FOR THE SEWER / PIPE TO BE REHABILITATED	3-8
3.7.1	<i>Design.....</i>	<i>3-8</i>
3.7.2	<i>Preparatory measures</i>	<i>3-8</i>
3.7.3	<i>Obstacles / Obstacle clearance</i>	<i>3-8</i>
3.7.4	<i>Cleaning procedures.....</i>	<i>3-8</i>
3.7.5	<i>TV Inspection</i>	<i>3-9</i>
3.7.6	<i>Requirements for the sewer to be rehabilitated (statics, hydraulics, operation and service life)</i>	<i>3-9</i>
4	QUALITY ASSURANCE.....	4-9
4.1	QUALITY ASSURANCE OF THE RENOVATION PROCESS	4-9
4.2	QUALITY ASSURANCE ON THE CONSTRUCTION SITE	4-10
4.3	MAINTENANCE OF THE RECEIVING WATER / FREEDOM FROM SEWAGE	4-10
4.4	INSPECTION	4-10
4.5	EQUIPMENT	4-11
5	3.6 INSPECTION AND STORAGE OF MATERIALS ON THE CONSTRUCTION SITE	5-11
5.1	THE INSTALLATION PROCEDURE USING THE EASYLINER SYSTEM IS CARRIED OUT BY	5-11
5.1.1	<i>Curing is either carried out by:</i>	<i>5-12</i>
5.2	PROCESS DESCRIPTION / EASYLINER SYSTEM	5-12
5.2.1	<i>Preparation / Equipment and material check</i>	<i>5-12</i>
5.3	MIXING SPECIFICATIONS / EASYPOX RESIN SYSTEMS	5-14
5.4	INSTRUCTIONS / EASYLINER SYSTEM.....	5-14
5.4.1	<i>Resin quantity required for house connection liners:</i>	<i>5-16</i>
5.4.2	<i>Resin quantity requirements for the main channels from 5.5mm in kg:</i>	<i>5-16</i>
5.4.3	<i>Resin quantity required for the main channels from 5.5mm in liters:</i>	<i>5-17</i>
6	PROCESS DESCRIPTION / SCAFFOLD INVERSION	6-23
6.1	4.1 PREPARATION / SCAFFOLDING / EQUIPMENT AND MATERIAL CHECK.....	6-23
6.2	INSTRUCTIONS / SCAFFOLD INVERSION.....	6-23
6.3	CURING AND COOLING	6-24
6.3.1	<i>Curing with hot water</i>	<i>6-25</i>
6.3.2	<i>Curing by means of hot steam for T0530</i>	<i>6-26</i>
6.3.3	<i>Theses.....</i>	<i>6-28</i>
7	EXAMINATIONS	7-28

7.1	LEAK TEST	7-28
7.2	ACCEPTANCE INSPECTION	7-28
7.2.1	<i>Optical examination</i>	7-28
7.2.2	<i>Taking of material samples</i>	7-28
7.3	SELF-MONITORING.....	7-29
	MONITORING OF THE TEST EQUIPMENT USED	7-29



Rombacher Hütte 19
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Phone +49 (0)234-579880

Manual
EasyLiner system

Status April 2017

Page 2-3 of 29

2 Scope of application

The EasyLiner procedure manual describes the rehabilitation technique for the renovation of underground pressure less drainage networks (open-channel pipelines) in public and non-public areas, as well as for pipelines within buildings, such as ground or down pipes, considering

DIN EN - ISO 11296 - 07/2011 - Part 1, Part 4, On-site curing pipe lining

The EasyLiner system covers the nominal widths of the above-mentioned connection and pipelines from DN 100 to DN 300.

3 Requirements

3.1 General information

The high-quality requirements for the design and manufacture of cured in place pipes using the hose lining method presuppose that the existing written specifications are observed and documented.

Work processes must be described and, if necessary, illustrated in process instructions and individual work steps in work instructions.

The personnel entrusted with the execution must be trained and must be familiar with the binding specifications in the work instructions.

Procedural and work instructions are an important component for a quality-assured process execution and must be proven with regard to all quality-relevant work for the execution of a remediation measure.

Applicable legal regulations for occupational safety, environmental protection and waste disposal must be complied with for each work step.

Proof of the basic suitability of the hose lining method for the production of high-quality EasyLiners must be provided in accordance with DIN EN ISO 11296-4, as well as for further requirements.


The building law approval is required for work in non-public areas.

3.2 Qualification of the company

The following proofs of qualification must be provided.

- In-house and external monitoring for production and installation
- Construction site documentation

Comprehensible references must be attached to the tender for the measures being tendered for.

 <p>Rombacher Hütte 19 44795 Bochum Phone +49 (0)234-579880</p>	<p>Manual EasyLiner system</p> <p>Status April 2017</p>	<p>Page 3-4 of 29</p>
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3.3 Materials used

The following requirements for the renovation system are met by the EasyLiner system:

- Resistance to municipal wastewater according to DWA A139 and DWA A115
- Static load capacity according to ATV M 127-2
- Tightness of the laminate according to DIN EN 1610
- Resistance to high pressure cleaning

3.3.1 Components / Structure

The EasyLiner system consists of the following components:

- Cold setting resin systems: EasyPox 1504/3008/4514/6024/9030
- Thermosetting resin systems: EasyPox T0530/T0880
- Base material: Polyester needle felt

Additional system-related components:

- Inner foil or coatings: PU
- Reinforcement (fiber reinforcements): Polyester fibers
- Additives or aggregates: not included

3.3.2 Materials

- resin system: Epoxy resin / EasyPox resin systems
- Curing system: Cold, warm with hot water support, Steam curing
- Backing material / reinforcement: Polyester fibers
- coating: PU/ modified PU

Hose / Hose carrier

The respective scope of the EasyLiner system must be selected in advance so that these reach the system in the pipe or sewer to be rehabilitated in a form-fit manner.

The radial expansion capabilities of the EasyLiner system for the respective application are approx. 20-25 %. This depends on temperature and pressure.


According to the specified installation conditions with regard to the inversion and installation pressure, the optimum adaptation to the old pipe is given.

3.3.3 Resin system / EasyPox resin systems

According to DIN 16946, part 2, the aforementioned resin system meets the requirements of types 1120-0, 1021-0 and type 1040 and is characterized by its insensitivity to moisture.

3.4 Impregnation on the construction site

For on-site impregnation, an impregnation unit corresponding to the area of application must be used, which complies with the commercial requirements.

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Storage and preparation of the EasyPox resin systems used and the respective EasyLiner systems are carried out according to the manufacturer's instructions.

The technical data sheets and material data sheets are to be kept available on site at all times and must be observed.

The mixing of the resin and subsequent impregnation of the EasyLiner system takes place protected from the effects of the weather.

For perfect impregnation, the correct vacuum in the hose liner and the adjustment of the calibration rollers are absolutely necessary. The vacuum must be maintained for the duration of the impregnation process.

The mixing and impregnation process is to be carried out according to the specified target specifications to document.

Target specifications:

Resin system: EasyPox T0530
Mixing ratio: 100: 30 (resin: hardener) by weight
Curing: Heat curing (>65 - < + 80 °)
Pot life: approx. 6 hours at + 20 °C

Resin system: EasyPox T0880
Mixing ratio: 100: 45 (resin: hardener) by weight
Curing: Heat curing (>65 - < + 80 °)
Pot life: approx. 8 hours at + 20 °C

Resin system: EasyPox 1504/3008/4514/ 6024/9030
Mixing ratio: 100: 25 (resin: hardener) by weight
Curing: Cold curing
Pot life: approx. 15, 30, 45, 60, 90 minutes at + 20 °C

Mixing time: EasyPox resin systems: at least 3 min, depending on quantity and starting temperature. (Avoid the inclusion of air!)

Calibration roller distance: 2 x the final wall thickness + 1 mm

Vacuum: Pressure gauge at 0.3 - 0.5 bar

Installation pressures: EasyLiner system = 0.3 to 0.5 bar (Permanent maintenance of pressure until complete curing).



3.5 Static proof

The static proof for the EasyLiner system is to be provided in accordance with ATV-M 127-2, whereby the long-term values from the initial test are to be applied considering the proven reduction.

The required long-term tests must be verified by an accredited testing institute and submitted with the structural analysis.

3.6 Constructional requirements / areas of application

The EasyLiner system is used in the following areas of application and installation equipment:

- Inspection manhole
- House (inspection opening inside)
- Inspection manhole

For the variant "downpipe rehabilitation" within buildings, the special requirements placed on the procedure must be considered.

3.6.1 Connection to the manhole area

The connection of the hose liner must be carried out with a positive fit and without back leakage.

In addition, it must be ensured that any existing annular gaps between the old pipe and the installed hose liner are protected against possible infiltration or exfiltration.

Suitable materials: Swelling tape, common duct mortars, EP resins

3.6.2 Connection to the main channel

The connection area of the hose liner in the main sewer must be created without any back leakage.

In the main sewer, which is not accessible to humans, the additional connection can be made using robot technology or the Easy-Top-Hat system (top-hat profile technology).

3.6.3 Connection of Inspection opening


As described under 3.6.1

3.6.4 Connection of connecting lines

The technical feasibility of a subsequent connection and the opening of existing inlets to the connecting pipe must be checked before the rehabilitation measure is carried out.

Proper connections can be built using robot technology or, if necessary, in open construction.

From a nominal width of DN 200, integration is possible using robot technology or top-hat profile technology.

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3.7 Requirements for the sewer / pipe to be rehabilitated

3.7.1 Design

For the success of a rehabilitation project, a careful inventory of the sewer pipes to be rehabilitated is a prerequisite.

Considering the static, structural and hydraulic conditions, it must be checked whether the EasyLiner system method can be applied.

The documents required for this purpose must be requested or prepared.

In addition to the usual damage patterns and existing characteristic data of the sewer pipes to be rehabilitated, the following points must be observed

- Nominal size changes
- Changes of Direction
- Position offsets
- Root ingrowing plants
- Existing connections
- GW infiltration
- Deformations
- Obstacles to runoff
- Dirt / deposits
- Pictures of damage

3.7.2 Preparatory measures

Before the start of the rehabilitation work, the following preliminary work must be carried out on the basis of the knowledge gained:

- HD Cleaning
- TV Inspection
- Milling work
- Dewatering
- any necessary traffic law measures

3.7.3 Obstacles / Obstacle clearance


Any damage detected during the inventory, such as obstacles, cross-section reductions, etc., which do not permit continuous high-pressure pipe cleaning or which could damage the EasyLiner system during inversion, is to be documented (TV inspection) and eliminated using suitable equipment.

The trouble-free discharge of the sewer must be permanently guaranteed.

3.7.4 Cleaning procedures

For the EasyLiner system rehabilitation, the HP cleaning must be carried out according to the condition of the sewer pipe.

The operating personnel must be informed about the respective sewer pipe condition.

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Further damage to the sewer pipeline to be rehabilitated must be avoided.

The cleaning result must be recorded and documented by a TV inspection in accordance with DWA guidelines.

3.7.5 TV Inspection

After the high-pressure cleaning has been completed, the sewer pipe to be rehabilitated must be inspected by means of a TV inspection immediately before the EasyLiner system is installed. This serves to establish that no further damage was caused during cleaning and, if necessary, milling work carried out to remove obstacles, deposits, etc.

The test result is to be recorded and documented by means of TV inspection in accordance with DWA guidelines.

3.7.6 Requirements for the sewer to be rehabilitated (statics, hydraulics, operation and service life)

The performance requirements for a rehabilitated sewer or pipeline are set out in DIN EN 752 (drainage systems outside buildings). The new system must be tight and resistant to the media introduced, to abrasion and to a practical high-pressure cleaning.

All expected static, thermal, chemical and biochemical loads must be considered when selecting the rehabilitation system. Mechanical cleaning procedures must be checked for their suitability before use.

A characteristic of hose liners is that they generally correspond to the surface structure of the sewer pipe to be rehabilitated, as they fit tightly. If bends and irregularities are present, as well as dimensional changes in the pipe to be rehabilitated, wrinkles can form due to the process.


"In the case of a straight pipe run with the same inside diameter, a hose liner must not cause any surface irregularities (wrinkles) that exceed two percent of the nominal diameter (DN) or six millimeters, whichever is greater". (DIN EN ISO 11296-4)

4 quality assurance

4.1 Quality assurance of the renovation process

Material tests for initial and suitability testing

Test laboratory:	F+E Ing. GmbH Plastics laboratory 90763 Fürth
Test report:	FE K 05105H091

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4.2 Quality assurance on the construction site

For each liner measure carried out, a complete documentation of all relevant process steps must be prepared. This must be kept in accordance with the retention periods for the period of the warranty. This enables a quick determination of the cause of any defects.

Correct documentation of the work carried out includes the following:

- Construction sites/day log
- TV inspection incl. recording
- Process dependent documentation of pressure and temperature parameters until complete curing.
- Pressure test protocols.
- Checking the flat widths of the EasyLiner systems in relation to the construction project.

Diameter	DN 100	DN 125	DN 150	DN 200	DN 250	DN 300
ThermoLiner plus	153mm	183mm	220mm	288mm	365mm	438mm
ThermoLiner 5.0	152mm	172mm	222mm	285mm	372mm	447mm
ThermoLiner Stretch	152mm	172mm	222mm	285mm	372mm	447mm
BendiLiner	138mm	165mm	210mm	268mm		
ThermoLiner S	152mm	172mm	222mm	285mm	372mm	447mm
SoftLiner	152mm	172mm	222mm	285mm	372mm	447mm

If technically possible and if commissioned by the client, a construction site sample of each measure must be prepared. If the local conditions or the EasyLiner system do not permit this, a work sample must be prepared and sampled according to the initial and suitability test.


4.3 Maintenance of the receiving water / freedom from sewage

Prior to any rehabilitation measure, it must be ensured that the water supply or wastewater is free of contamination. Any infiltration or discharge of waste water into the section of pipeline to be rehabilitated must be avoided.

If necessary, the area to be rehabilitated must be kept free of water by means of backwater, transfers or diversions.

4.4 Inspection

To determine that the sewer pipe to be rehabilitated has been cleaned to an extent sufficient for the EasyLiner system, a TV inspection including documentation of the inspection results is required. This is for safety reasons, so that the EasyLiner system can be used during the inversion into the existing sewer pipe cannot be damaged.

 Rombacher Hütte 19 44795 Bochum Phone +49 (0)234-579880	Manual EasyLiner system Status April 2017	Page 4-10 of 29
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4.5 Equipment

For the quality and environmentally compatible application, the state of the art and the applicable regulations must be observed. EasyLiner system systems, regarding

- Safety
- Noise and emission protection
- Keeping air, soil and groundwater clean

an absolute prerequisite.

The EasyLiner system is designed in such a way that during the installation the required process-relevant data can be constantly checked by appropriate testing, measuring and control equipment or, if necessary, recorded.

The measuring and control equipment is subject to continuous monitoring, but at least once a year. These inspections must be documented in the company's own interest.

All equipment may only be operated by professionally trained personnel who are familiar with the relevant operating instructions.

5 3.6 Inspection and storage of materials on the construction site

The materials required for the renovation are to be subjected to an incoming inspection at the construction site in principle and in particular. During this process, the EasyLiner system must be checked for obvious damage.

All materials are to be used in accordance with the manufacturer's specifications or our process instructions so that the quality of the EasyLiner system and the individual components can be impaired in any way.

The environmental, industrial safety and hazardous goods regulations must be observed when storing and processing resins, hardeners and additives.


5.1 *The installation procedure using the EasyLiner system is carried out by*

- Inversion (turn inside out)

Water, air or steam can be used as the driving or installation medium.

Inversion (turn inside out)

During the installation process using the EasyLiner system, the respective installation conditions and installation instructions must be considered. The pressure required for the overturning process must be maintained constantly. This ensures that the EasyLiner system fits or can fit into the existing sewer pipe with a positive fit. Thus, a bulge from the outside can be avoided, if necessary with existing ground water etc.

 <p>Rombacher Hütte 19 44795 Bochum Phone +49 (0)234-579880</p>	<p>Manual</p> <p>EasyLiner system</p> <p>Status April 2017</p>	<p>Page 5-11 of 29</p>
--	--	------------------------

5.1.1 Curing is either carried out by:

- Warm hardening / water, steam
- Cold curing / ambient conditions

Hot curing

For the hot hardening process, the respective process instructions must be observed with regard to the parameters listed below:

- Temperature curve (resin temperature) according to protocol diagram
- Time sequence according to protocol documentation
- Internal pressure set up pressure 0.3 to 0.5 bar (larger for groundwater etc. according to protocol)

Curing under ambient conditions

The curing time is to be checked on the basis of a work sample to be prepared, which cures under the same conditions as the installed EasyLiner system.

After complete curing the final measures are taken as follows:

- Opening and watertight production of closed inlets
- Open EasyLiner system at the beginning and end

The EasyLiner system bonds to the old pipe (tight fit).


Avoid backflow by using a suitable channel mortar or swelling tape.

5.2 Process description / EasyLiner system System

5.2.1 Preparation / Equipment and material check

Check the inversion drum:

- Move the inversion drum into position (align), connect the air supply from the compressor and close the ball valve.
- Close the pressure reducer and turn it back (open), close the ball valve at the pressure gauge (maximum pressure build-up at the pressure reducer 2.5 bar).
- Install the inversion hose with the appropriate length (manhole depth).
- Install nozzles or bends according to the direction and size of the EasyLiner system.
- Wind up the control tape evenly and tightly (make sure that the control tape is long, control tape is at least EasyLiner system, inversion drum and inversion hose length).

 <p>Rombacher Hütte 19 44795 Bochum Phone +49 (0)234-579880</p>	<p>Manual EasyLiner system</p> <p>Status April 2017</p>	<p>Page 5-12 of 29</p>
--	---	------------------------


- Pull the pull rope with loop through the inversion hose to the connecting piece (fix the loop outside the inversion drum). Provide lubricating oil.
- Hose clamps with endless thread - for connecting the control band to the EasyLiner system.
- Cordless screwdriver with corresponding hexagon (nut), small ratchet and special armour tape - for connecting the control strap to the EasyLiner system and as protection.
- Clamps (check size) - for fastening the EasyLiner system to the inversion spigot or bend.

Check- EasyLiner system:

Checking the lengths, diameters and wall thicknesses supplied. Determine the pipe length and check the nominal diameter of the entire sewer pipe (cross-sectional changes).

At the same time infiltration must be considered.

- EasyLiner system, length determination for renovation with "open end": + 1.0 m for integration (10 cm connection piece, bend) and approx. 20 cm distance from connection piece to start of pipe, + approx. 70 cm for vacuum.
- EasyLiner system, length determination for renovation with "closed end": + 1.0 m for integration (10 cm socket, bend) and approx. 20 cm distance from the socket to the start of the pipe, + approx. 70 cm for vacuum and closed end.

 <p>Rombacher Hütte 19 44795 Bochum Phone +49 (0)234-579880</p>	<p style="text-align: center;">Manual</p> <p style="text-align: center;">EasyLiner system</p> <p style="text-align: center;">Status April 2017</p>	<p style="text-align: right;">Page 5-13 of 29</p>
--	--	---

5.3 Mixing specifications / EasyPox resin systems

EasyPox resin and hardener components, which are supplied in containers with matching quantities, are to be mixed carefully (min. 3 min.) using slow-running mechanical stirrers. If only a partial quantity of the resin container is used, the resin bucket must be stirred briefly beforehand until a streak-free state is achieved. For this purpose, the hardener component B into the larger sized container of resin component A.



Important: It is imperative that the container is emptied completely.

Compliance with the mixing ratio is therefore guaranteed and is also necessary for ecological reasons.

Mixing ratio:

EasyPox 1504, 3008, 4514, 6024, 9030

Cold curing, weight = 100:25

EasyPox T0530
EasyPox T0880

Hot curing, weight = 100:30
Hot curing, weight = 100:45

5.4 Instructions / EasyLiner system System

The required length of liner material is cut to length from the roll: For this purpose, the exact length of the old pipe must be measured. An additional 0.3 m is added for the inversion-side connection of the EasyLiner system.

At the other end of the EasyLiner system, which forms the closed end, another 0.7 m is required. The corresponding lengths are marked with a pen. This means that the entire EasyLiner system is approximately one meter longer than the sewer pipe to be rehabilitated.



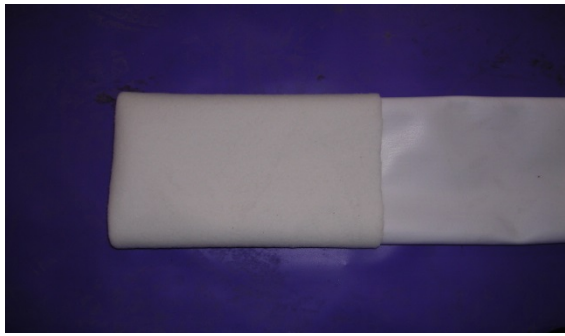
Rombacher Hütte 19
44795 Bochum
Phone +49 (0)234-579880

Manual
EasyLiner system

Status April 2017

Page 5-14 of 29

The inversion-side end of the EasyLiner system is extended by an edge width of approx. 0.1 m turned over. This is the so-called brim. This is to be closed airtight.



A vacuum hose with suction cup is connected to the previously marked 0.7 m long extension of the EasyLiner system, making sure it is airtight.

From lengths > 10.00 m, a cut is made in the top coating every 10.00 m. This cut must not be made in the seam area. The cut is approx. 15 mm long and may only be made through the coating. This is necessary to achieve a good result when "pulling" the vacuum (-0.5 bar). These incisions are to be closed with adhesive tape.

The EasyPox container (or the entire quantity of resin) must be filled into the liner which has been prepared according to the length to be rehabilitated. For this purpose, the liner is folded like a "Z". This "Z" is weighted down with a weight. A vacuum can therefore form between the "Z" and the suction cups.

If necessary, a "Z" should also be folded behind each suction cup and weighted down with a weight.



The impregnation process must be stopped at a safe distance in front of the suction cup and the suction cup removed.

Apply the THF solvent with a brush to the prepared PU film piece (approx. 50 x 50 mm) and cut (coating) of the EasyLiner system. After flash-off, the PU film piece is applied directly to the incision (coating) of the EasyLiner system without wrinkles. If any areas have not yet been bonded, rework must be done between EasyLiner system and the PU film piece. Carefully absorb excess solvent.

The impregnation process using the impregnation table must be adapted to the speed at which the EasyPox resin is absorbed into the felt of the EasyLiner system due to the vacuum. Care must be taken to ensure that the seam areas of the EasyLiner system have also been well impregnated.

The respective resin quantity requirements are to be determined using the EasyLiner system quantity tables. Here, the local conditions (e.g. temperature) and the possible procedure for installation must be considered. The respective pot life and curing times of EasyPox resin systems can be found in the technical data sheets.

5.4.1 Resin quantity required for house connection liners:

Liner type	Gap in [mm]	Resin requirement in kg/m [kg]									
		50	63	70	80	100	125	150	200	250	300
ThermoLiner plus	10					1,40	1,65	2,20	2,75	3,65	4,41
ThermoLiner 3.5	7					1,02	1,15	1,50	1,90	2,50	3,00
Thermoliner 5,0	10							2,25	2,88	3,76	4,55
Bendiliner	7	0,50	0,65	0,65	0,85	1,05	1,25	1,57	2,00		
ThermoLiner Stretch	10					1,50	1,80	2,25	2,88		
ThermoLiner S	10					1,45	1,65	2,20	2,70	3,55	4,30
Softliner	7			0,70	0,80	1,00	1,20	1,50	1,90	2,50	3,00

5.4.2 Resin quantity requirements for the main sewers from 5.5 mm in kg:

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

5.4.3 Resin quantity required for the main sewers from 5.5 mm in liters:

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

The pot/processing times must be selected so that the EasyLiner systems are installed in the sewer pipe to be rehabilitated after only 2/3 of the specified pot/processing times. A reserve of 1/3 of the pot life must be considered.

The pot/processing time starts immediately after mixing the EasyPox resin components A+B. It is important that only the number of resin containers whose contents can be filled and distributed as quickly as possible is used.

The resin quantity required must be precisely calculated.

The mixing time must be noted in the protocol.

On the basis of the recorded times, the total time required until complete curing can be determined.

The required resin quantities should be filled into the EasyLiner system immediately after mixing. The filling side is the side of the EasyLiner system that is attached to the cone/bow.



After filling, impregnation/calibration must be carried out immediately to distribute the resin quantities as quickly as possible.

As soon as the first part of the resin is filled, the resin container or weight can be removed. The EasyPox resin is sucked in assisted by the vacuum. In case of longer EasyLiner systems, i.e. larger resin quantities are required, the resin can be filled in stages from both ends of the EasyLiner system. In this case, care must be taken that the vacuum is not interrupted between the resin and the more distant end.

The EasyLiner system is impregnated using an electric or manual impregnation table. Care must be taken to ensure that the rollers are correctly adjusted.

Adjustment of the rollers: The gap must be set to twice the thickness of the raw felt.

ThermoLiner plus	: 2x5.0 mm =	10 mm gap
ThermoLiner 3.5	: 2x3.5 mm =	7 mm gap
ThermoLiner 5.0	: 2x5.0 mm =	10 mm gap
BendiLiner	: 2x3.5 mm =	7 mm gap
ThermoLiner Stretch	: 2x5,0 mm =	10 mm gap
ThermoLiner S	: 2x5.0 mm =	10 mm gap
SoftLiner	: 2x3.5 mm =	7 mm gap

The seam of the liner must be aligned upwards to ensure that it can be continuously checked for complete impregnation. The vacuum must be maintained during impregnation. No resin may enter the vacuum hose during this process.

The remaining EasyPox resin can thus be completely distributed into the liner system.

After completion of the uniform impregnation, the liner is fed into the inversion drum with the closed end first and connected to the control rope/webbing.

For this purpose, two hose clamps (or similar) are passed over the EasyLiner system end folded in a Z-shape and tightened. Then this area must be covered with armor tape so that the sharp edges of the hose clamps (or similar) cannot cause any damage during inversion.

At ambient temperatures above + 25 °C the EasyPox resin should be cooled and the impregnation protected from sunlight. At cooler ambient temperatures the impregnation can be carried out on site (min. processing temperature + 5 °C).



The control tape/webbing in the inversion drum must be wound up tightly. Now the liner can be wound up on the shaft as well. Do not forget to lubricate the EasyLiner system while it is being wound up. Commercially available sponges or a spray bottle are suitable for this. Wetting both sides of the liner is very important. The lubricant ensures good sliding during inversion.

The EasyLiner systems must be wound evenly and tightly over the entire width of the shaft. This facilitates subsequent inversion.

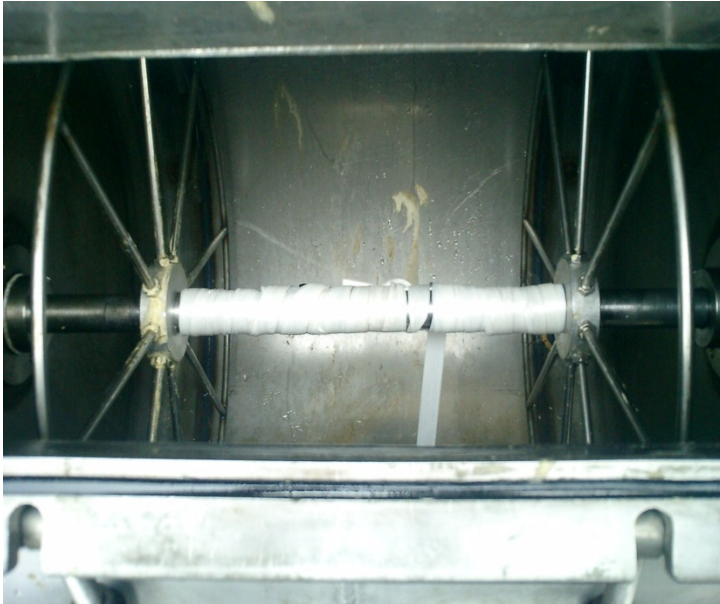


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44795 Bochum
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Manual EasyLiner system

Status April 2017

Page 5-19 of 29



At ambient temperatures above +25 °C, the liner must be kept cool (e.g. in a water bath) and the inversion drum must be cooled with cold water (e.g. from the hydrant).

When the end of the liner has reached the drum, a rope, which has previously been pulled from the cone or elbow through the inversion hose into the inversion drum, is attached to the inverted end of the EasyLiner system.

The EasyLiner system is then pulled through the inversion hose to the cone or elbow and the upside-down end of the EasyLiner system is attached with suitable hose clamps.



Rombacher Hütte 19
44795 Bochum
Phone +49 (0)234-579880

Manual EasyLiner system

Status April 2017

Page 5-20 of 29



Make sure that the connections are airtight. The mounting window of the inversion drum must also be tightly closed.

The inversion can now be performed as follows: In the manhole, the cone or elbow is positioned at a distance of approx. 0.2 to 0.3 m from the sewer pipe to be rehabilitated into position. Make sure that the soaked EasyLiner system is applied in order to ensure an optimum bond.



To ensure that the maximum amount of air is available for inversion of the EasyLiner system, the compressed air control valve must be set to max. A support hose must be used between the nozzle and the start of the pipe to avoid exposed areas. Due to the different inversion pressures of the respective EasyLiner system, the pressure gauge attached to the inversion drum must be constantly checked. From approx. 0.2 bar the liner starts to invert (it turns inside out). This is indicated by the fact that the handwheel starts to rotate. To support the inversion, it can be rotated by hand.



Rombacher Hütte 19
44795 Bochum
Phone +49 (0)234-579880

Manual EasyLiner system

Status April 2017

Page 5-21 of 29

As soon as the liner has entered the sewer pipe to be rehabilitated, the bend or socket is secured in the manhole.

Under constant, continuously controlled inversion pressure, the liner must be inverted at a constant speed. This ensures that the liner can adapt optimally to the sewer pipe to be rehabilitated.

In the case of existing pipe bends and also strong pipe offset, a higher inversion pressure may be necessary for a short time.

Inversion pressures:

From approx. 0.2 bar, the liner begins to invert. Smaller diameters require higher pressures, larger diameters require lower pressures. If bends or dimensional jumps have to be passed, it may be necessary to increase the pressure.

If the rehabilitation is carried out from manhole to manhole, the EasyLiner system in the target manhole exits from the sewer pipe to be rehabilitated. When rehabilitating from the inspection manhole to the main sewer, the exit can be observed by means of a TV camera.

As soon as the EasyLiner system is completely inverted, the hand wheel is locked to the inversion drum.

The installation pressure, which must be maintained until complete curing, is adjusted via the pressure control valve and monitored via the pressure gauge.

The installation pressures are between 0.3 and 0.5 bar depending on the EasyLiner system used.



Rombacher Hütte 19
44795 Bochum
Phone +49 (0)234-579880

Manual **EasyLiner system**

Status April 2017

Page 5-22 of 29

If a further EasyLiner system rehabilitation is planned, the inversion drum can be removed, i.e. a plug with air connection must be inserted and connected to the EasyLiner system to maintain the installation pressure.

Important notice:

EasyLiner system must not be depressurized in case of infiltration. There is a risk that penetrating water will wash resin out of the felt and thus complete curing in the affected areas cannot take place.

6 process description / scaffold inversion

6.1 4.1 Preparation / Scaffolding / Equipment and material check

Scaffolding:

In the run-up to the renovation work, the scaffolding must be the required inversion height (geodetic height). The relevant accident prevention regulations must be strictly observed.

According to the erected height, the inversion tube must be adapted with the inversion elbow or connecting piece and then securely hooked into the scaffold. A rope must then be pulled into the inversion tube to feed the EasyLiner system through.

Alternatively, the EasyLiner system can also be inverted according to the inversion height and hung in the scaffold (inversion collar). The tools, lubricants, heating and cooling systems required for inversion and filling hoses and holding ropes must be provided in advance. This serves to ensure that the inversion can be performed without unforeseen delays.

Heating systems which are used for curing the liner must be subjected to a functional test in advance so that the temperature supply can be started immediately after inversion.

Check- EasyLiner system:


Checking the lengths, diameters and wall thicknesses supplied, Determine the pipe length and check the nominal diameter of the entire sewer pipe (cross-sectional changes).

At the same time infiltration must be considered.

EasyLiner system, length determination for renovation with "closed end" (manhole to manhole): +1.0 m for the integration (10 cm socket, bend) and approx. 20 cm distance from socket to start of pipe, + approx. 70 cm for vacuum and closed end.

In the case of preimpregnated liners, the inversion height must be considered, as this must be inverted in advance.

6.2 Instructions / Scaffold inversion

 <p>Rombacher Hütte 19 44795 Bochum Phone +49 (0)234-579880</p>	<p>Manual</p> <p>EasyLiner system</p> <p>Status April 2017</p>	<p>Page 6-23 of 29</p>
--	--	------------------------

After the EasyLiner system has been completely impregnated, it is lifted onto the scaffold in stages with the aid of a rope etc., with one end passing through the inversion hose with elbow/nozzle.

The initially remaining EasyLiner system material must be aligned in preparation for inversion so that this can run smoothly.

The end that is passed through is to be attached to the elbow/spigot by means of e.g. "bandit tape".

Once this work has been completed, inversion can be initiated by adding water. The EasyLiner system first runs through the inversion hose and after it exits at the connection piece/bend, it runs into the posture to be rehabilitated.

It is important here to control the inversion evenly by adding water. During the inversion, the EasyLiner system is turned inside out, i.e. the resin-impregnated felt reaches the old pipe to the system.

If a preliner is used, this reaches the system on its inside. In this case there is no bonding with the old pipe.

After the EasyLiner system is half inverted, the hose end and the holding rope and the temperature-resistant heating hoses must be attached to it.

To continue inversion up to the target manhole, make sure that any air that may be present can escape from the EasyLiner system.

6.3 Curing and cooling

The heating circuit required for curing is provided by the heating hose, which is inserted simultaneously during inversion, and the suction hose, which runs inside the pressure drum up to the sole area.

This is to be connected to the suction/pressure pump leading to the outside.


The heating hose must be connected to the suction/pressure pump and the latter to the hot water generator used by means of a hose.

Via the suction hose, the process water, which has already been cooled down for heat transfer, is fed from the pressure drum to the hot water generator for heating.

The process water must be heated to start the curing process of the resin system according to the manufacturer's instructions. The heating, holding and cooling phases must be observed according to the manufacturer's instructions.

To avoid tension/shrinkage in the cured EasyLiner system must be slowly cooled down from the curing temperature level to ambient temperature via the process water after curing (hydrant). Ambient temperature approx. 20 °C to 25 °C.

The supply and return temperatures must be checked and documented at 30-minute intervals on the heating system, start, intermediate and target manholes.

 <p>Rombacher Hütte 19 44795 Bochum Phone +49 (0)234-579880</p>	<p>Manual</p> <p>EasyLiner system</p> <p>Status April 2017</p>	<p>Page 6-24 of 29</p>
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6.3.1 Curing with hot water

The heating circuit required for curing is provided by the heating hose, which is pulled in during inversion, and by the heating hose which extends to the sole area leading suction hose within the water column.

For larger nominal widths/lengths, several hoses with different lengths can be used.

The heating hose must be connected to a suction/pressure pump which must be connected to the hot water generator used in each case. Via the suction hose, the process water from the water column, which has already been cooled down for heat transfer, is fed back to the hot water generator for heating.

According to the manufacturer's instructions, the water must be heated in order to start the curing process of the resin system. The heating, holding and cooling phases must be observed according to the manufacturer's instructions.

To avoid tension/shrinkage in the cured EasyLiner system must be slowly cooled down from the curing temperature level to ambient temperature via the process water after curing is complete.

Ambient temperature approx. + 20 °C to + 25 °C. The flow and return flow temperatures must be checked and documented at 30-minute intervals on the heating system, start, intermediate and target manholes.



Resin	Ratio	Temperature [between old pipe and liner]	Return [Heating]	Hardness time
1504	100:25	>60 °C	>75 °C	Not recommended
		>50 °C	>65 °C	>40 min.
3008	100:25	>60 °C	>75 °C	>30 min.
		>50 °C	>65 °C	>60 min.
4514	100:25	>60 °C	>75 °C	>45 min.
		>50 °C	>65 °C	>90 min.
6024	100:25	>60 °C	>75 °C	>60 min.
		>50 °C	>65 °C	>120 min.
9030	100:25	>60 °C	>75 °C	>90 min.
		>50 °C	>65 °C	>180 min.
T0530	100:30	>60 °C	>75 °C	>4 hours
		>50 °C	>65 °C	>8 hours
T0880	100:45	>60 °C	>75 °C	>6 hours
		>50 °C	>65 °C	>12 hours

The values mentioned are the pure hardness time. The time for bringing to temperature and the cooling phase are not considered. The data given in the table are based on empirical values with continuous heat input. The concrete temperature conditions caused by ground water, pipe material and outside temperatures must also be considered.

6.3.2 Curing by means of hot steam for T0530

During steam curing, the necessary pressure in the liner must be generated by means of air. If the pressure is sufficient, the liner will form-fit to the old pipe to be rehabilitated in accordance with the manufacturer's instructions; any water present must be removed completely beforehand. The steam is introduced into the liner at the start manhole via a valve of the steam system using a control system that includes a manometer for pressure tracking and a thermostat for temperature control.

When working from manhole to manhole, a valve must also be attached to the hose at the end of the liner and any condensation water that occurs must be drained off via a drain.

When working from manhole to manhole, the steam outlet at the end of the liner a pressure gauge and a valve for pressure regulation and control to. The temperature is controlled by means of a thermometer.

When working from the inspection manhole to the main sewer, a flow valve must be installed in the liner at the end of the liner or calibration hose before it is installed.

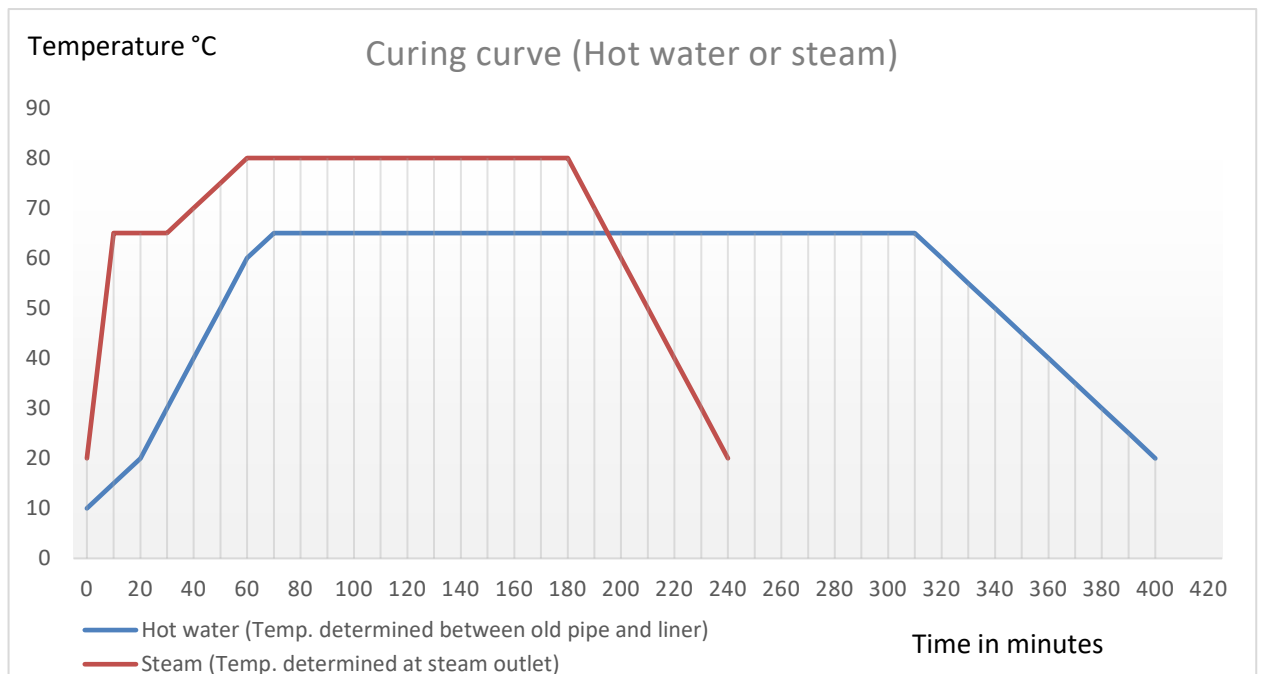
The vapor pressure in the hose must be continuously and ideally approx. 0.3-0.4 bar, pressure drops below the latter value must be remedied immediately, temperatures and pressure curve must be recorded.

At the beginning of the curing process, steam inlet and, if necessary, outlet must be adjusted to approx. +65°C and the liner must be subjected to this steam temperature in a controlled manner for 30 minutes. Afterwards the temperature can be increased step by step to +80°C. This initial gentle curing and the duration of the heating depends on the liner dimension and the ambient temperature.

Once the steam temperature of +80°C has been reached at the steam inlet and outlet, this temperature must be maintained at a constant level for approx. 2 hours, depending on the resin/hardness combination used and the structural conditions.

To avoid tension/shrinkage in the cured EasyLiner system must be cooled down slowly (~ 30 to 60 minutes) from the curing temperature level to ambient temperature after curing
(depending on dimension and wall thickness)

All the above values must be continuously checked, corrected if necessary and recorded at intervals of at least 15 minutes without interruption.



6.3.3 Theses

The EasyLiner system is opened in the start and destination manholes by means of compressed air-driven cutting tools and connected without any risk of migration. In intermediate manholes, only the upper half shell of the EasyLiner system is removed up to the manhole berm (step).

In the start and finish manholes the EasyLiner system can be opened as follows:

Manhole walls: with projection of approx. 2 cm to 3 cm.

Intermediate manholes: Remove half shell (top) up to manhole top.

If characteristic data of the installed material are required, the samples required for the verification must be taken from the test tubes created.

A leak test requested by the customer is carried out, if necessary, before opening any lateral inlets that may be present and that have been closed by the EasyLiner system.

In the nominal width range DN 150 to DN 300, rehabilitated sewer pipes can be tested with air (method L) according to the specifications of Table 3 - DIN EN 1610, test method LB for dry concrete pipes. The rehabilitated sewer pipe must be visually inspected and documented. It must be ensured that no residual material or hydraulic changes, e.g. folds, are present.

7 Examinations

7.1 Leak test

After completion of the renovation work, a leak test according to DIN EN 1610 must be carried out as part of the self-monitoring before opening existing inlets. This covers the entire renovated area or the renovated sections.

Checking the technical feasibility in the run-up to the leak test.

If the customer waives the leak test, this must be done in writing.

According to the specifications, the leak test is a separately chargeable service.

7.2 Acceptance inspection


7.2.1 Optical examination

After completion of all measures in the renovated holding, a visual inspection is carried out by TV inspection according to ATV M 143.

The inspection result must be documented on video or pictures, as well as in a protocol.

7.2.2 Taking of material samples

The construction site sample taken can be used to assess the material quality.

 <p>Rombacher Hütte 19 44795 Bochum Phone +49 (0)234-579880</p>	<p>Manual</p> <p>EasyLiner system</p> <p>Status April 2017</p>	<p>Page 7-28 of 29</p>
--	--	------------------------

To take a sample from the construction site, it is recommended to pass the EasyLiner system through a sample pipe or, if necessary, a support hose before starting the installation. Samples that appear to have an insufficient impression when being taken should be discarded.

Removal directly from the renovated holding (milling work) should be avoided (see 3.2).

7.3 Self-monitoring

The self-monitoring is carried out as listed below:

Incoming goods inspection
Documentation (installation & production) / (fill out protocols promptly)
Suitability test
Construction site sampling

Monitoring of the test equipment used

All test equipment that is required for the documented proof of the quality of the renovated pipeline must be subjected to regular inspection with calibration standards or certified reference measuring instruments. These include in particular measuring instruments for pressure and temperature measurement.

History:

07/2016	Steam extension / integrated tables
08/2016	Resin consumption tables maintained
01/2017	Resin consumption table Error Thermoliner S eliminated
04/2017	Resin consumption table main channels added



Rombacher Hütte 19
44795 Bochum
Phone +49 (0)234-579880

Manual

EasyLiner system

Status April 2017

Page 7-29 of 29