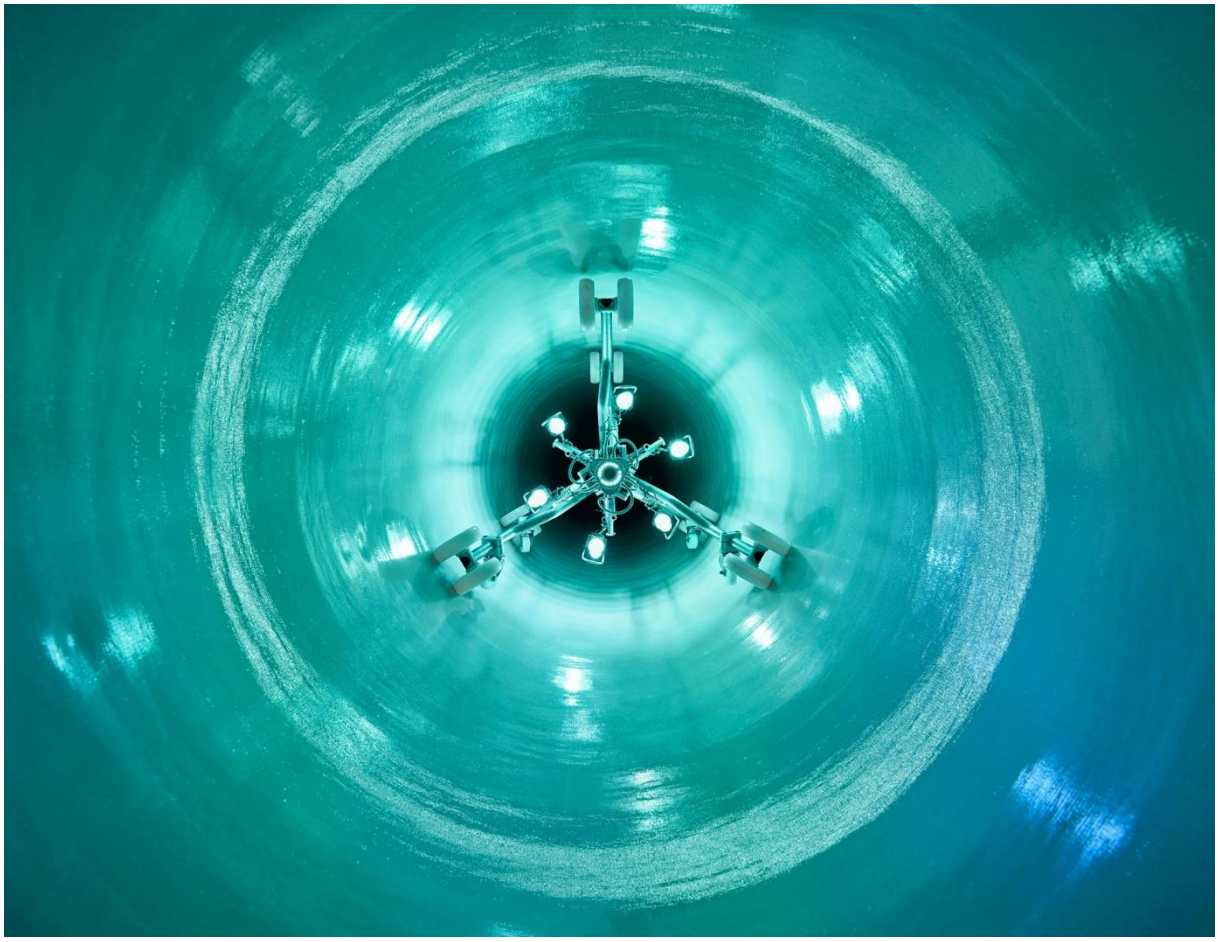


Installation manual

Brandenburger CIPP Lining

BB$^{2.5}$ Liner

BB$^{2.0}$ Liner

Brandenburger Liner GmbH & Co. KG
Taubensuhlstr. 6
D – 76829 Landau
Tel: (+49) (63 41) 51 04-0
E-mail: info@brandenburger.de
www.brandenburger.de

Landau, 9 February 2022

© Installation manual **BB$^{2.5}$**, **BB$^{2.0}$** Liner Brandenburger CIPP Lining
Version: 2.0
Approved: 08/02/2023
Published: 09/02/2023

CONTENTS

1 PRELIMINARY REMARKS

This procedure manual describes how to perform sewer rehabilitation operations using the Brandenburger CIPP lining method. Due to the different conditions, as well as the circumstances of the individual sewer, the particular characteristics of the site have to be considered and adhered to. This information does not represent a contractual document.

Making copies, transfer of the entire manual or parts thereof, electronic processing or publication of the entire manual or parts thereof are only allowed with the written permission of Brandenburger Liner GmbH & Co. KG. Violations will be prosecuted.

A binding assurance of certain qualities or suitability in various installation scenarios cannot be derived from the information provided by us.

The recipient or user of the Brandenburger pipe liner is responsible for complying with any applicable trademark rights and other laws and regulations.

© **Installation manual February 2023**	**Date: 09/02/2023**
This installation manual is the property of:	Brandenburger Liner GmbH & Co. KG Taubensuhlstr. 6 D-76829 Landau, Palatinate, Germany

2 OVERVIEW

The described procedure is a pipe lining procedure in accordance with DWA –M 143-3 and in which the locally produced and hardened pipes are produced for the rehabilitation of damaged underground sewage pipes with circular profile cross sections of DN 150 to DN 1600 and oval profile cross sections of 200/300 mm to 1200/1800 mm. The system is based on a flexible tube made of glass fibre that is impregnated with a reaction resin composition (typically unsaturated polyester resin) and additional foils. This will be referred to as a liner in the following text. The impregnation of the liner is performed at the liner factory. The installation of the liner takes place in one or more rehabilitation conduits defined by two or more shafts or line openings. The liner is pulled into the line using a pulley, typically with winch support and sliding protective foil, pulled onto packers and expanded using air pressure.

Curing is performed by exposure from a UV light source. The entire curing process is controlled and documented using installed sensors.

The finished product is a statically stable, seamless, flexible plastic pipe.
The liner can be employed for rehabilitation of pipes, typically sewers, made of concrete, steel concrete, vitrified clay, fibre cement, GFRP, PVC-U, PE-HD or cast iron, as long as the diameter and the special conditions of the sewage pipe to be rehabilitated meet the process-dependent specifications and the static requirements.

3 WORK AND HEALTH PROTECTION / TRAFFIC SAFETY MEASURES

3.1 WORK AND HEALTH PROTECTION

For all work at the construction site, the relevant national regulations on work and health protection of the country of installation and the country of origin of the user are to be observed.

Examples for the Federal Republic of Germany are the law on the performance of occupational safety measures for improvement of safety and health of employees at work (Arbeitsschutzsgetz –ArbSchG) and the regulation on safety and health on construction sites (Baustellenverordnung – BaustellV) in the current versions.

Additional references are the safety regulations and operating instructions of the respective equipment manufacturer.

The measures to be taken as defined in the work and health protection law result from, among other sources, the process-relevant and site-related risk analyses and operating instructions that must be prepared.

3.2 TRAFFIC SAFETY MEASURES

Observe all traffic safety regulations of the country where the Brandenburger pipe liner is being installed. If public traffic routes are used in the Federal Republic of Germany, this means that special use permits/traffic law orders are to be applied for with the competent authority, according to which the traffic safety measures are to be performed.

These provisions apply starting as far back as the work regarding the liner measurements.

4 PREPARATION

4.1 CONSTRUCTION SITE INSPECTION

We recommend to survey the construction site during the inspection. A traffic ordinance may be required for this work. The shafts of the conduits to be rehabilitated are inspected visually, and the diameter and length of these shafts are compared with the figures indicated on the map.

4.2 LINER MEASUREMENTS

The measured lengths and dimensions are to be compared with the theoretical measurements from the sewer probe and/or conduit reports to be able to evaluate any discrepancies immediately. When planning the installation sequence, take into account that it is not possible to perform robot work (e. g. opening connection lines) and inliner work simultaneously in the same shaft.

4.2.1.1 LINER DIMENSIONING

The measurements of the pipes are checked in both shafts. When surveying the shafts, the rules and regulations of the work and health laws are to be observed. The measurements are made vertically (12-6 clockwise) and horizontally (9-3 clockwise). The measurements in mm are to be specified in the order.

In special cases, please note point 5.2.

As the measurements at the sleeves ends in the upstream shaft can lead to incorrect values, in particular for small pipe sizes, it is important that the measurement be taken in the pipe!

If the profile to be measured is not a round pipe, the pipe circumference must be measured on the inside wall of the pipe with a measuring tape. A complete calibration is required if there are clear and visible deformations likely to affect the stress characteristics of the pipe liner.

4.2.1.2 LINER LENGTH

The liner length results from the pipe length plus 1 m.

The measurement is performed aboveground with a measuring tape or roller tachometer. It must be

ensured that there is no bend in the conduit that could falsify the length; in such a case, the measurement should be made in the pipe using a TV inspection camera or a sewer robot using an attached steel or GFRP tape measure. For conduits with standard shafts of DN 1000 with a centrally mounted cone, a significantly accurate liner length can be calculated from the measurement of shaft centre to shaft centre. For special structural designs of the shaft structures, appropriate increases or reductions must be taken into account.

4.2.1.3 ORDER LENGTH

The order length results from the liner length plus extra material for the binding of the liner head, setting the packer (0.6 – 1 m for the use of a pulling head) and any sample taking. The liner length is calculated by measuring from the shaft centre of the draw-in shaft to the shaft centre of the end shaft.

4.2.1.4 WALL THICKNESS/LINER MATERIAL

The wall thickness to be ordered and the type of liner material are determined by the associated stress calculation; a minimum wall thickness may be specified by the builder. In principle, Brandenburger liners are designed according to the regulations for a groundwater pressure of 1.5 metres water column, measured from the bottom of the liner. Pressures exceeding this lead to higher wall thicknesses and must be taken into account when ordering, as otherwise a later failure (breakage) of the liner cannot be ruled out.

With respect to the chemical and thermal stress due to the wastewater, the resistance tables are to be used. Any chemical or thermal stress caused by factors other than domestic wastewater must be evaluated using a water analysis. Using this water analysis, Brandenburger can provide information on resistance.

4.2.1.5 CONSECUTIVE CONDUITS

If multiple conduits are rehabilitated in successions, the intermediate shafts are measured. In addition, the individual lengths must be determined and documented.

Adjacent conduits can be rehabilitated using one single liner under the following conditions:

- The cable of the rehabilitation vehicle is of sufficient length.

- The conduits must be of the same diameter.
- The conduits and the gutter must be in a straight line (no bends in the shaft). In case of deviations, consult an application technician from Brandenburger
- The water drainage, specifically the residential connections, must be controllable.
- In the intermediate shafts, there may not be any base cracks.

4.3 ORDER

For the liner order, the order form from Brandenburger can be used. The form is designed so that all data required for smooth order processing is listed.

Orders or changes to the orders must be made in writing.

If a schedule for the individual installations must be met, then Brandenburger must be consulted when the order is placed so that this can be taken into account in the production plan.

4.4 TRANSPORT AND STORAGE OF THE LINER

The liners are to be transported and stored properly in the wooden boxes. It is necessary to protect the liner from direct weather influences (sun, moisture, frost), ambient light, artificial UV light, temperature changes and mechanical damage. The liners are to be stored in closed, temperature-controlled facilities. Both during transport and storage, the temperature must be kept between +5 °C and +30 °C. Deviations from the prescribed storage and transportation conditions can affect the durability of the liner and impair or prevent proper installation.

	Storage temperature	
	+5°C and +30°C	+12°C and +20°C
UP resin	12 weeks	26 weeks
VE resin	6 weeks	12 weeks

Fig. 1 Table of storage times

The peroxide liner has to be installed immediately and has always to be transported and stored refrigerated (temperatures are always to be requested on a project basis) until the installation. In case of any warranty claims the storage conditions must be fully and verifiably adhered to.

The minimum installation temperature measured at the laminate for liners is +15 °C. If required, you may need to heat up the liner up to +15°C measured at the laminate. The laminate temperature at the start of the installation procedure is to be documented in the installation log.

If the laminate temperature is too low, processing may be harder or not possible at all and this will also have a negative impact on curing and thus the quality of the liner.

We recommend using a radial compressor, in particular in winter. Using a radial compressor increases the temperature when installing the liner. This has a positive effect on elongation pattern of the liner.

Depending on the type of vehicle, loading equipment may be required on-site. Waste containers (for waste containers, see Notification for local residents Directory of waste codes) should be provided for the disposal of any construction debris.

Determine a suitable storage place to store the liner and park the rehabilitation vehicles before performing the rehabilitation.

The resin mixture for the UV liner contains light-initiators that enable curing of the liner with UV light. These initiators also react to normal ambient light and are temperature sensitive. The external foil protects the liner from UV rays of the ambient light and should not be removed or damaged before using the liner. Should it be damaged, the foil must be patched with a light and moisture-impermeable adhesive tape so, that neither UV-light nor water and other liquids get to the liner.

4.5 NOTIFICATION FOR LOCAL RESIDENTS

Well before the start of the construction project, the manner in which the local residents will be notified must be clarified with the builder and then carried out according to this agreement (see appendix Traffic safety measures 8.2).

4.6 TV PRELIMINARY INSPECTION

In principle, a TV inspection must be carried out immediately after installation. The TV inspection is used to evaluate the feasibility of rehabilitation of the sewer, to check the underlying structural conditions used for the offer, and to determine damaged areas to be milled and the type of liner installation. A camera inspection needs to be performed on the sealed and cleaned sewers. This is the only way to obtain a realistic assessment of the damage (sewer bed must be visible and free of sewage).

Landau, 9 February 2022

5 PREPARATIONS PRIOR TO INSTALLING THE LINER

5.1 REMOVAL OF PROTRUDING OBJECTS

All objects that protrude into the line profile must be removed.

Protruding obstructions must be removed or smoothed out to prevent damage to the pipe liner during the insertion or when expanding with air.

If obstructions are not removed, bumps and folds may form in the liner and thus prevent the liner from curing properly (damage to inner and/or external foil).

The position of loose wall parts must be secured using suitable rehabilitation techniques.

Typical examples are:

- Protruding connections
- Protruding seals and
- Protruding fragments
- Roots
- Fixed deposits
- Pipe connector offsets / severely displaced connections
- Fixed foreign bodies

5.1.1 PROTRUDING CONNECTIONS

These are removed using a milling robot with TV monitoring to achieve an even transition between the connection and main line.

5.1.2 INTAKE REHABILITATION

Severely broken intakes are to be rehabilitated before inserting the inliner to achieve a form-fitting connection to the main sewer.

5.1.3 ROOTS, FIXED DEPOSITS, INCRUSTATIONS

All objects and obstacles that protrude into the line profile and cannot be removed using high-pressure cleaning must be removed using mechanical methods (such as a sewer robot).

5.1.4 PIPE CONNECTOR OFFSETS / SEVERELY DISPLACED CONNECTIONS

It is important to always check whether the rehabilitation can be performed without using an open construction method. If it is possible to perform the rehabilitation without digging, the offsets at the connections can be milled away with a robot so that a smooth transition is achieved.

For pipe connector offsets, the circumference is reduced at certain points so that the liner cannot expand to its full dimension in the radial direction. For dimensions up to DN 200, there is a risk that the light source will get caught on larger pipe connector offsets. Pipe connector offsets that are not dealt with, in particular for dimensions up to DN 250, can impair or prevent the sewer robot from being able to move through the cured liner to open the residential connections.

5.1.5 INCOMING GROUNDWATER

If groundwater is seeping into the conduit to be rehabilitated, the corresponding locations must be sealed before installation of the liner. Installation of a preliner may be necessary. One criterion for the necessity of a groundwater seal is, for example, a strong continuous inflow of water. The conduit must be dry.

Fig. 2 Preliner

Before drawing-in the liner into the preliner, calibrate it once with air.

Fig. 3: Incoming groundwater Unsecured shackle

Caution: An unsecured shackle can damage the preliner when drawing the liner in. It is therefore very important that the shackle is covered with foil or tape.

Fig. 4 Incoming groundwater secured shackle

Even for the use of a preliner, before drawing the liner in a sliding protective foil is to be drawn into the preliner. This makes it possible to draw in the liner with a minimum of force.

5.2 SPECIAL REQUIREMENTS

5.2.1 MINOR CHANGES IN DIAMETER

For conduits with minor changes in dimension within a section, it is important to ideally prepare the liner for production and design the foil packaging in such a manner so that only low force is required for the expansion of the laminate when installing the liner by means of compressed air.

Please add the note **"Minor changes in dimension"** when ordering such a liner!

It is indispensable to store the liner in advance at suitable temperatures (18°C - 22°C) for minor changes in dimension to avoid exerting any additional strain on the inner foil when installing the liner.

Reduce the pressure steps to 20 - 50 mbar to ensure that the material can expand evenly within the range of minor changes in dimension. Ideal results can be achieved with this procedure.

5.2.2 REDUCTION IN DIAMETER – LONGITUDINAL CREASES IN LINER

During the curing process, the light source / main lamp may snag on the creases. This may damage the inner foil. It may not be possible to open the branch pipes once creases have formed, as the robot may be unable to navigate past the creases.

5.2.3 EXPANSION OF DIAMETER – OVERSTRETCHING THE LINER

It is possible to use wall thicknesses below the minimum specification in areas where the liner is not subject to back pressure. In areas without support, the liner may burst due to overstretching. In order to quantify minor changes in dimension, the conduits to be rehabilitated must be measured. This can be done, for example, through:

- Manual measurement of the old pipe diameters
- Tactile (touching) measurement of the conduits (e. g. system "Optimess" or equivalent)
- Contactless laser scans of the conduits

5.2.4 CHANGES IN DIRECTION

In case of significant changes in direction, radial creases result in the inside of the bend and empty spaces are formed on the outside of the bend between the liner and old pipe. There is also a risk that the drawing rope will damage the inner foil when the light source is drawn through. It has proven to be successful to use a coated cable for changes in direction, since this reduces the frictional resistance considerably. After curing by the first lights, in particular in small sizes, the light source may get caught on creases (it can then be blocked in both directions!) or the inner foil can be damaged by the drawing rope so that air escapes into the core, resulting in liner failure. In addition, if the change of direction is too big, the sliding protective foil and liner may fold over.

5.2.5 LOWER SEGMENTS

To install and determine the condition of the liner, the water needs to be pumped out of the sewer from the lower segments using an appropriate method.

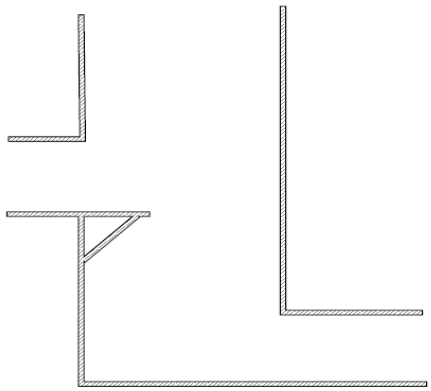
5.2.6 MISSING SECTIONS OF PIPE WALL

If sections of the pipe wall are missing, a pre-rehabilitation needs to be performed using a suitable method or a preliner or a support cap must be used. Pre-curing with low expansion pressure is typically not possible. In such a case, when the pressure is increased to the operating pressure, in the transition area between the precured and not precured area, cracks may form in the core (leaks and/or failure to achieve the required static properties).

5.2.7 CONCEALED INTERMEDIATE SHAFTS

Open concealed intermediate shafts wherever possible. Try to gain access in order to protect the liner against overstretching in the shafts. If it is not possible to access the shafts, the liner has to be protected from overstretching by using an additional preliner . Pre-curing with low expansion pressure is typically not possible.

5.2.8 PIPE CRASH; SLIPPAGE



If the pipe does not end in a shaft base, it may be necessary build a platform.

Fig. 5 Platform

5.3 LEVELLING THE RESIDENTIAL CONNECTIONS

Before drawing the liner in, the residential connections must be levelled exactly.

Levelling is necessary as the intakes are typically no longer visible after liner installation. It may be the case that the contours of the intakes can be recognised, but this should not be relied on.

5.4 WATER ENTERING THE INSTALLATION SHAFTS

It must be prevented that water enters into the liner ends at the installation shafts, as this can lead to saponification of the resin, resulting in uneven curing. Therefore, it is advisable, in particular for very shallow networks, to use a stop valve to also secure the lower shaft against back pressure from the network. It is also necessary to prevent water from entering the not-cured liner, as all areas

where water is present (e. g. lower segments) will experience uneven curing of the liner. Here preliminary sealing of the shafts or continuous pumping off of water during installation may be necessary. In any case, it must be ensured that the structure to be rehabilitated is free of water.

If the special conditions and ambient conditions are expected to cause severe moisture penetration of the structure to be rehabilitated, a moisture measurement must be carried out prior to rehabilitation. A strong presence of moisture can prevent the liner from curing completely, so that this can lead to an insufficient curing result despite the high product quality of the Brandenburger product. In this case, prior drying or a liner with PE can be used.

Landau, 9 February 2022

6 CONSTRUCTION SEQUENCE

6.1 TRAFFIC REGULATIONS

Before the start of rehabilitation, the construction site must be secured. It must be ensured that the shafts that must remain open during installation are blocked off and secured. The traffic regulations and signs must be in accordance with the traffic ordinance (see also 6.2.2 3.2).

6.2 WATER DRAINAGE ((maintaining drainage)

During installation, the conduit must be kept free of entering water. In addition, it must also be ensured that the shafts have been prepared such that the cut-open liner ends do not come into contact with water.

In case of minor deviations from these optimal installation conditions, curing is still possible as a rule. The risks of such an installation and the resulting deficiencies must be assessed by the user, who is then responsible for the resulting consequences.

It must be clarified with the builder whether the flow can be throttled for the duration of the work using technical measures. If there are pumping systems in the upper reaches of the main sewer or in the backwater area of the merging residential connections, it must be ensured that the pumps are turned off.

6.2.1 SETTING STOP VALVES

Stop valves must always be secured against slipping out (e. g. in case of air loss). Sewer spindles or a wood construction can be used here.

6.2.2 BACKUP

Depending on the weather and the water transport, in many situations it is possible to hold back the incoming wastewater during liner installation with sealing plugs.

In such cases, you have to consider the depth the sewer and the position of the residential connections. If the sewer conduit is shallow, it is recommended that you reroute the incoming water, as holding it back could flood the cellars of the adjacent houses. In many houses there is no backwater valve or ones that do exist do not work properly, meaning wastewater could flow directly into cellars.

If there is rain overflow in the backwater area, there is a risk that wastewater could be discharged into public waters. A plug in the drain line can prevent this from occurring.

Caution: The pressure of water hold back is considerable!

6.2.3 REROUTING

If the quantity of incoming water is so great that holding it back during liner installation is not possible, the water must be pumped into suitable tubes via the decommissioned conduit.

Caution: Even wastewater lines with small quantities of water can experience a great increase in water flow in case of rain.

6.2.4 RESIDENTIAL CONNECTIONS

It must be taken into account that multi-family houses and industrial building can have such a high wastewater load that the retention capacity in the corresponding branch pipe lines can be reached very quickly, making it necessary to reroute out of the inspection openings.

In case of mixed-water sewers and road drainage lines, the backwater area can fill very quickly in case of rain. If the water pressure in the lines exceeds the inside pressure of the calibrated (but not yet cured) liner, the liner will deform (1 m water column is 0.1 bar). In such cases, a solution may be to separate the rainfall lines and close the gullies before beginning liner installation.

6.3 CLEANING THE CONDUIT TO BE REHABILITATED

Directly before drawing the liner in, the rehabilitation line must be cleaned using high-pressure flushing and inspected with an inspection camera for obstacles; this inspection is to be recorded onto a suitable data medium.

The inspection run can also be used to make the necessary rope connection.

Note: It is recommended that the sewer cleaning tanker remain at the construction site until the conduit has been inspected by the camera. This will allow you to clean out any remaining residue in another flushing cycle.

6.4 DIRECTION OF INSTALLATION

6.4.1 DRAWING IN THE LINER

It is recommended that you draw the liner in the direction of flow.

Advantages:

- Reduction of the pulling forces
- Any existing water (lower segments) is drawn out of the conduit
- With heavy liners using sliding means (BB^{LGM} / “Kanalflutschi”) is recommended.

6.4.2 LINER CURING

It is recommended that the liner is cured against the direction of flow; this applies in particular for conduits with a relatively steep incline.

Advantage:

- As the light source "rolls", when curing is performed against the direction of flow the source must be pulled uniformly "uphill". A stop-and-go effect resulting from the downhill movement of the chain and blocking by the then sagging cable is avoided.

6.5 DRAW-IN PROTECTION

6.5.1 GUIDE PULLEYS

To protect ropes and cables, guide pulleys must be used.

Pulley fastened in the gutter or shaft for drawing in the sliding protective foils, preliner or liner

Fig. 6 Guide pulley, fastened

To protect against outside forces when drawing in the sliding protective foils, preliner and liner, the guide pulley is secured by fastening it or doweling.

6.5.2 EDGE PROTECTION

To protect the liner against sharp edges (manhole rim, start of the pipe) when drawing the liner in suitable protective measures must be taken (e. g.: covering, shaft ring a.o. to protect the edges). Remove or cover any other protruding obstructions in the shaft before drawing in the liner (e. g. fully cover manhole steps with a piece of sliding protective foil).

Positioning of the liner at the shaft, with shaft ring to protect the liner during the insertion.

Fig. 7 Edge protection at the shaft

Draw-in protection at the start of the pipe with foil.

Fig. 8 Draw-in protection at the start of the pipe

6.6 DRAW-IN PROTECTION

Sliding protective foil needs to be installed to prevent liner from becoming damaged in the old pipe (rough pipe walls, broken fragments, pipe connector offsets etc.) and to reduce the pulling force. The

sliding protective foil must be used unless otherwise indicated below.

For Liners with the additional external protection, the sliding protective foil may optionally be omitted. This is dependent on weight and construction site and can be decided according to the old pipe condition.

However, additionally protect the liner head with slide protection film.

When using liner with integrated protective film or (ZA) at the liner head additional preparatory work is necessary before installing the liner in the sewer to be redeveloped to protect the liner head from damage/abrasion because the liner head is heavier per unit area than "just" a linear meter of liner.

Measurements for protection of the Liner.

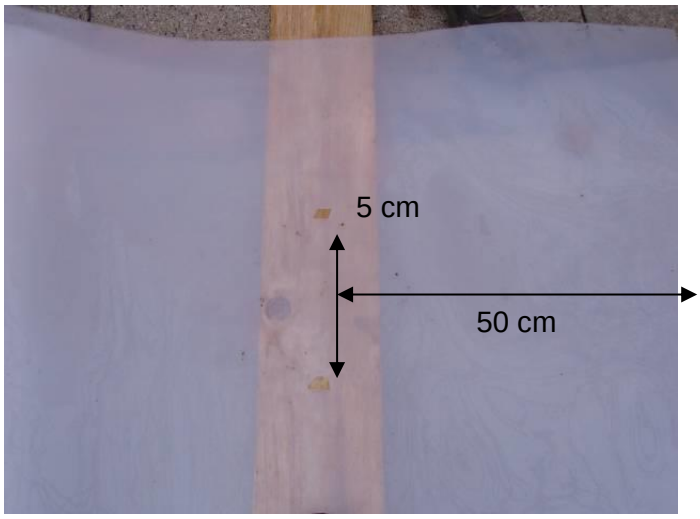
The sliding protective foil role is positioned above the shaft.

Fig. 9 Positioning the sliding protective foil at the shaft

6.6.1 BINDING THE SLIDING PROTECTIVE FOIL

The start of the sliding protective foil is folded so that when drawn into the sewer, it is not possible for it to get caught on pipe connector offsets, fragments, etc. At this "head" the drawing rope (pulling the rope with the camera or the winder) and another rope – which lies loose on the sliding protective foil during the draw-in process (which serves as the drawing rope for the cables of the winch after the sliding protective foil has been drawn in) – are attached. To draw the sliding protective foil in, the light-source draw-in aid or the winch can also be used. To prevent the sliding protective foil from being pulled along when the liner is drawn in, in the shaft from which the liner draw-in process is performed the sliding protective foil must be secured.

Fig. 10 Sliding protective foil



Cut holes into the sliding protective foil (preliner) after 50 cm (from the start of the sliding protective foil) left and right from the centre (e. g. 5 cm for DN 250) .

Fig. 11Opening for the curing rope (example DN 250)

A curing rope is now pulled through the two openings from behind. The length of the curing rope depends on the width of the sliding protective foil.

Fig. 12 Threading the curing rope

The sides of the sliding protective foil are rolled together toward the centre.

Fig. 13 Rolling up the sliding protective foil

The sliding protective foil is fixed with the curing rope, which was guided through earlier.

Fig. 14 Sliding protective foil ready for use

Fig. 1 Sliding protective foil ready for use

6.6.2 DRAWING-IN THE SLIDING PROTECTIVE FOIL

The conduit to be rehabilitated should not have any large changes in direction. The preliner could fold over there and make it impossible to draw the liner through.

The winch cable is drawn in using the curing rope that was pulled in with the TV inspection.

When drawing in the sliding protective foil, use an anti-twist swivel between head and winch cable and draw in the curing rope with the head.

It has generally proved quite effective to apply some lubricant to the sliding protective foil in order to reduce the force required for drawing in the liner.

Secure the winch cable to the sliding protective foil using a shackle and an anti-twist swivel.

Fig. 15 Winch cable on the sliding protective foil

Insert sliding protective foil and curing rope.

Fig. 16 Inserting sliding protective foil and curing rope

Cut sliding protective foil in the shafts and secure it.

Fig. 17 Sliding protective foil in the winding shaft

The end of the winch rope is reattached to the curing rope carried and pulled into the conduit.

Fig. 18 Sliding protective foil in the circular profile sewer

6.7 PRELINER

When working in ground water interchange zones or even in groundwater, check whether a temporary seal is required to prevent water infiltration before installing the liner (see 6.11.1 5.1.5).

A preliner can also be used to protect the liner against overstretching or damage at the apex.

The order length is the pipe length plus sufficient extra length for fixation.

If used, the preliner is drawn into the conduit first. The sliding protective foil is then drawn into the closed preliner. After drawing the sliding protective foil in, the preliner must then be erected with air again.

6.7.1 BINDING THE HEAD

The preliner lies flat on the ground. A round sling is placed on the preliner about 80 cm to 1.0 m from the beginning of the preliner. The length of the round sling should be equal to the width of the liner plus at least 20 cm.

Fig. 19 Round sling and preliner

The end is folded over once.

Fig. 20 Wrapped preliners

The preliner is then folded together toward the centre.

Fig. 21 Folding the preliner

After folding up the preliner, it is fixed with 1-2 tie-down straps.

Fig. 22 Fixing the preliner with tie-down straps

6.7.2 DRAWING IN THE PRELINER

The step "drawing in" is identical (see 6.2.2).

After being drawn in, the preliner is to be closed on both ends and filled with air, as the layers could stick together due to the production process. During filling the rope in the preliner is to be secured. With it, the winch cable is pulled in the following step.

The preliner is then to be secured in the opposing pipe, the outlet or on the shaft wall so that it:

1. Cannot be pulled along when the liner is drawn in.
2. Allows as little water as possible to enter.

Whenever possible, the liner should be drawn in the direction of flow. This makes it possible for the water to drain out easily.

Note:

An anti-twist swivel needs to the installed between the winch cable and the hook/shackle to prevent tangles and twists in the cable from being transferred to the liner. The liner may twist if the anti-twist swivel is left out.

6.8 LINERHEAD

The position of the liner crate is vital when making the liner head.

- Liner crate against draw-in direction (a):
  The top layer of the liner in the crate can be folded lengthwise.
- Liner crate in draw-in direction (b):
  The top layer of the pipe liner needs to be turned 180° first, because otherwise the locks on the tie-down straps are on the sewer base when the liner is drawn in. With large diameter liners, it would also be difficult or impossible to "unfold" the liner after it has been drawn in. The method against the direction of flow can only be used for diameters up to DN 400.

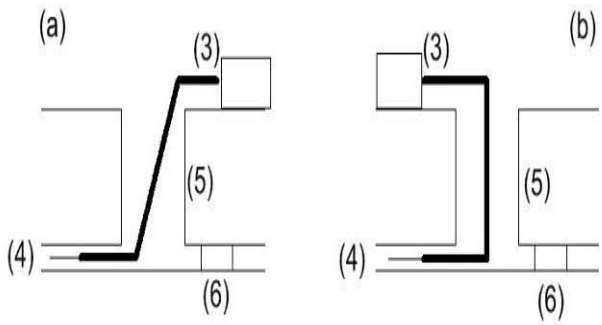


Fig. 23 Positioning of the liner at the shaft

a) Drawing in with liner crate against the direction of flow

b) Drawing in with liner crate in the direction of flow (only up to DN 400 and liners without AP! Not possible with liners with the AP, as the AP would be then on the top.

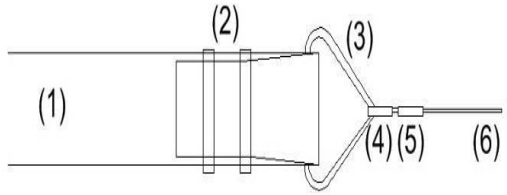
3) Pipe liner in transport crates

4) Direction of pull

5) Shaft

6) Sealing plug

6.8.1 BINDING OF THE LINER HEAD



1) Pipe liner
2) Tie-down straps (number depending on liner diameter and liner weight)
3) Round sling
4) Hook
5) Anti-twist swivel
6) Winch cable

Fig. 24 Making the liner head

The liner is laid flat on the ground.

Fig. 25 Liner flat on the ground

At a distance of 0.80 - 1.0 m from the end, place a round sling on the liner and fold over the liner end once. The length of the round sling should be equal to the width of the liner plus at least 20 cm.

Fig. 26 Round sling in the liner

Fig. 27 Folding the liner

Fig. 28 Fixing the liner

The liner head is fastened with tie-down straps.

Fig. 29 Completely tied liner head

Fix the liner head as tightly as possible with tie-down straps (e. g. DN 500, 100 m min. 5 tie-down straps).

It has proved useful to protect the liner head with an additional piece of sliding foil to prevent damage to the liner head.

6.9 DRAWING IN THE LINER

The liner must be positioned above the shaft so that it can be easily lowered into the shaft.

Fig. 30 Liner draw-in from the transport box

If the liner is wider than the diameter of the shaft opening, it should be folded before being lowered into the shaft to make sure that it can pass through the shaft into the sewer pipe easily (no damage to external foil). Remove manhole steps or protect using sliding protective foil.

Fig. 31 Drawing the folded pipe liner into the conduit

Always use an anti-twist swivel when drawing in the liner in order to prevent the pipe liner from folding over due to twists in the cable.

Fig. 32 Anti-twist swivel with hooks

There is a risk that the liner will fold over in particular under the following conditions:

- Small, lightweight pipe liners
- Kink in the conduit to be rehabilitated
- Twisted liner during draw-in (incorrect insertion)
- Draw-in speed too high for small dimensions

The pipe liner should be guided in a way that prevents it from twisting. Drawing at a low speed in conduits with bends reduces the chances of the liner folding over.

Landau, 9 February 2022

If a conveyor belt is used for drawing in the liner, the liner must be folded in front of the conveyor belt to prevent the layers of the liner from shifting. When folded, it is easier for the liner to get through the shaft opening and into the shaft. The end of the liner must be secured to prevent it from falling from the conveyor belt and into the shaft.

Fig. 33 Liner draw-in using conveyor belt

When using the winch, the cable should move smoothly over the pulley through the centre of winding shaft.

Personnel should not enter the shaft while the winch cable is under tension.

Fig. 34 Winch cable of the winch on the guide pulley

Once the liner is in draw-in shaft and the shackle has arrived at the pulley, the load is removed from the winch cable, the shackle connection opened and the liner head unfolded.

Fig. 35 Draw-in liner in the shaft

During the draw-in procedure, observe the following:

- For heavy liners using lubricant.
- At the start of the draw-in procedure or after an interruption, start the winch at a low speed
- Try to avoid stops or interruptions (very high pulling forces when restarting the winch)
- Do not exceed the maximum pulling forces (see liner data sheet).
- Once the final layer of pipe liner can be seen in the crate, reduce the speed so that the liner head approaches the pulley slowly
- Pull the liner into the shaft far enough so that it is possible to set up the packer and take a sample
- All liners tend to retract once they are released. Here, the desired end position should be achieved by pulling a number of times and only then should the order be given to make the cut. / Liner should be rested approx. 5 minutes with tension. Preliner should be cut before.
- Fasten a cable to the end of the liner before lowering it into the shaft.
- As long as the winch keeps the drawing rope under tension, no one may enter the shafts.
- The pulling force during the draw-in procedure must be recorded (winch draw-in log) (for maximum draw-in forces, see the liner data sheet).

6.10 WORKING IN SHAFTS

6.10.1 DRAW-IN SHAFT

- Cut off the liner about halfway down the shaft
- Tape the edge of the liner with short strips of adhesive tape, working from the inside of the liner over the edge to the outside along the whole circumference.
    - This prevents water at the bottom of the shaft from coming into contact with the resin, which would cause the liner to saponify.
    - It also prevents the inner foil from being pushed into the liner when installing the light source.
- Position the UV system with arm of the cable drum above the centre of the shaft,
- otherwise set the upper guide pulley.

6.10.2 WINDING SHAFT

1) Sliding protective foil
2) Guide pulley frame
3) Wood bar to support liner when cutting
4) Support cap/protection against overstretching

Fig. 36 Winding shaft

Cut off the liner about halfway down the shaft; tape the edge of the liner with short strips of adhesive tape, working from the inside of the liner over the edge to the outside along the whole circumference. Push the support cap (overstretch protection) onto the liner.

Air cut lengthwise approx. 2 cm into the external foil should be done, so that any air can escape.

6.10.3 APPLYING THE SWELLING TAPE

- Cut the swelling tape to the dimension of the conduit to be rehabilitated (e. g. DN 300 x 3.14 = 942 mm).
- Glue the ends together.
- Push the newly formed ring over the liner.
- Install the swelling tape approximately 5 to 10 cm from the start of the pipe to be rehabilitated
- Push the swelling tape, cut to size, into the intermediate shafts under the liner and then glue and install

6.11 SETTING THE PACKER, WINDING SHAFT

Make sure packers have been thoroughly cleaned. Resin residue or sharp edges and burrs on the packer must be removed before applying the liner as otherwise the inner film may be damaged when installing the liner. This type of damage may cause the installation to be unsuccessful. In any case, this will lead to deviations in quality. Recommendation: Mask the edge of the packer with plenty of adhesive tape as a precautionary measure!

Fig. 37 Rope in packer

Guide the white draw-in cord through the liner through the packer and the Venturi nozzle of the packer cover and connect with the knot-free curing rope. The curing rope serves as a draw-in aid for the light chain. Check whether the internal draw-in cord and the curing rope for drawing in the light chain move easily

Fig. 38 Venturi nozzle

6.11.1 DN 150 TO < DN 500

When installing the packer, make sure to avoid any damage to the inner foil!

Use the palm of a hand to lift the liner at the apex, smooth out creases in the base and at the apex and push the packer into the resulting opening.

Push the packer into the liner until the stud bolts are at the liner end.

The packer is securely bundled together using at least two or three tie-down straps.

Fig. 39 Packer with tie-down straps

Place the cover on the packer and seal with the included locking system.

Fig. 40 Packer with cover

6.11.2 DN 500 TO DN 1600

Fasten 1 or 2 clamps to the apex of the liner. Attach a rope to the clamps. Pull the clamps up from outside the shaft. Install the packer as described in **Fehler! Verweisquelle konnte nicht gefunden werden.**. For DN 700 and larger, the liner should be setup again before installing the packer to facilitate installation.

Fig. 41 Liner with screw clamps

Note: At DN 700 and above, the packers are divided into sections so that it can fit through the shaft opening. The packers are assembled in the shaft and installed as described above.

Fig. 42 Collapsible packer (1)

Fig. 43 Collapsible packer (2)

Fig. 44 Collapsible packer (3)

6.12 SHAFT WORK

6.12.1 INTERMEDIATE SHAFTS

In all intermediate shafts in the rehabilitation line, the liner must be protected against overstretching, as this could cause the liner to burst. This must be done with a support cap. This is the only way to acquire representative samples.

Care must be taken that the support cap is not allowed to wedge, particularly in the case of brick profiles, thus not allowing stretching of the liner.

Fig. 45 Support cap with closing options

Pre-curing with low expansion pressure is typically not possible. In such a case, when the pressure is increased to the operating pressure, in the transition area between the precured and not precured area, cracks may form.

6.12.2 WINDING SHAFT

Establish the connection between the packer and air supply. To check the pressure build-up, use a pressure gauge close to the compressor or condenser.

Fig. 46 Connection of packer – condenser/compressor

Constantly monitor the pressure while pressurising the liner to specification. If the pressure gauge indicates no pressure, then the air supply has to be cut immediately and a check needs to be made whether the air hose connection between the pressure gauge and the hose connection at the packer in the winding shaft is interrupted.

When the pipe liner is slightly pressurised, re-tighten the tie down straps on the packer in the winding shaft. When the compressed air supply is removed, small-diameter pipe liners usually remain standing. (see appendix 8.4)

Fig. 47 Re-tightening the tie-down straps

6.12.3 DRAW-IN SHAFT

Close the open pipe liner end and fill the liner with air from the winding shaft until the liner stands.

Fig. 48 Liner kept closed

Secure the draw-in cord in the shaft

Fig. 49 Draw-in cord in hand

6.13 INSTALLING LIGHT SOURCES

Before drawing the liner in, the lamps of the light source should be tested and left on for at least 3 minutes to detect any defects early on.

Note: The test run of the light source is to be performed so that it is not possible for employees or passers-by to look directly into the light source when it is on as this could injure the eyes.

The light source is typically installed at the draw-in shaft.

During installation of the light source, ensure that the inner foil is not damaged!

6.13.1 LIGHT SOURCE DN 150 – DN 500

6.13.1.1 INSTALLING LIGHT SOURCES

- Expansion of the liner with air from the winding shaft (approx. 100 mbar)
- Pull the curing rope through using the draw-in cord in the direction of the draw-in shaft
- expanding the liner again with compressed air (approx. 100 mbar)

Note:

The curing rope should not be secured to the light source without an intermediate anti-twist swivel.

Fig. 50 Light source with anti-twist swivel for curing rope

- Connection of the curing cable with the light source

Insertion of the light source into the liner by carefully pulling the curing rope and pressing in the draw-in shaft until it is in the pipe 10-20 cm from the beginning of the pipe

Fig. 51 Drawing in the light source

- This process should be monitored on the screen (image from curing camera).
- Once the light source is completely in the liner, remove the compressed air supply.
- After installation of the light source remove the light of the camera!
  This is necessary because the light of the curing camera gives off a insignificant UV radiation which can cause a local curing process of the liner in the area of the camera. The optical control of the liner during calibration time should be carried out sporadically. After the complete calibration of the liner, the light of the camera can again be used constantly.

6.13.1.2 INSTALLING THE PACKER

- Before installing the light source, it is recommended that you set the packer above the curing cable and connect the curing cable with the light source.
- Then carefully lower the packer on the rope and into the shaft.
- Verify the cable connections by checking the function of the camera image and the temperature sensors.
- Set packer according to the description in 6.11.2

6.13.2 LIGHT SOURCE DN 500 – DN 1600

6.13.2.1 PREPARATION

- Insert the packer into the draw-in shaft and winding shaft as described in section 6.11.2
- Keep the opening of the Venturi nozzle closed and fill the liner with compressed air from the winding shaft (50-100 mbar).
- Secure the draw-in cord in the shaft.
- Pull the curing rope through using the draw-in cord in the direction of the draw-in shaft
- Switch off the condenser/compressor at the winding shaft.
- Open the packer cover in draw-in shaft.

6.13.2.2 BUILDING AN INSTALLATION AIRLOCK

- Pull an airlock foil (inner foil with the dimension of pipe to be rehabilitated) over the installed packer and fasten it with a tie down strap.

Note: For dimensions starting with DN 500, a corresponding airlock foil is included in the liner crate

- Secure the curing rope to the main light.
- Carefully insert the main lamp into the airlock foil fastened to the packer so that the main light is in the airlock foil directly in front of the packer.

Fig. 52 Installation airlock

- Keep the end of the airlock foil closed by hand.
- Expand liner with compressed air from the winding shaft
- Insert the main light into the liner by carefully pulling the curing rope and pressing in the draw-in shaft until it is in the pipe 10-20 cm.
- This process should be monitored on the screen (image from curing camera).
- Remove the compressed air supply
- Remove the airlock
- Lock the packer cover at the packer
- Insert the Venturi nozzle in the provided opening.
- Establish the air hose connection from the packer cover to the UV system.
- Expand the liner with compressed air (compressor/condenser) at 50-100 mbar.

The packers must be installed in the shafts. Only at or above this pressure is it safe to assume that the liner has expanded fully and is in the pipe without any creases.

Note: Depending on the dimension and pressure, significant forces act on the packers (see data sheet)

6.14 PROTECTING THE LINER AGAINST OVERSTRETCHING

After installing the packer in end shafts, a support cap is placed around the liner between the beginning of the pipe and the packer.

The support cap used should not expand either longitudinally or radially and have the same diameter as the conduit to be rehabilitated.

The support cap protects the liner from overstretching in the area near the packer.

After curing, a sample can be taken here. Intermediate shafts that are also being rehabilitated need to be protected with textile-reinforced support caps against overstretching of the liner (also refer to 5.2.7). Pre-curing with low expansion pressure is typically not possible. In such a case, when the pressure is increased to the operating pressure, in the transition area between the precured and not precured area, cracks may form. In intermediate shafts, support caps with closing options are particularly useful.

Note:

Before setting the support caps, relief cuts of 2 – 3 cm in length are to be made in the light protective foil so that any air between the liner and foil can escape.

Support cap with closing option in intermediate shaft.

Fig. 53 Support cap with closing option in intermediate shaft

6.15 LOGGING

At the start of the setting up the liner, recording of the curing process is started.

All relevant data shall be recorded electronically. The logging interval shall not exceed 30 seconds; this is a basic requirement for the processing of any complaints. The relevant details are:

- Pressure in mbar
- Traversing speed and location of the light source in cm
- Temperature measured at the liner surface
- Ignition status of the lamps

The associated site protocol should include weather conditions, outside temperature and condition of the sewer with documentation. A video recording of the liner in place as the light source moves to the starting point is strongly recommended.

6.16 EXPANDING THE LINER WITH COMPRESSED AIR

The compressed air supply can be switched on again after the light sources have been installed and the packer in the draw-in shaft has been closed.

First check whether the pressure gauge hose for the compressed air is connected to the packer in the winding shaft and to the UV system. This hose is used to measure the pressure inside the liner. If air pressure is applied to the liner with the compressor or the condenser and the compressed air indicator on the control panel of the UV system and the pressure gauge on the back side of the UV system indicate no pressure, then the air supply has to be cut and a check needs to be made whether the air hose connection between the UV system and the liner is interrupted.

Expand the liner in steps of 50 mbar until 150 mbar have been achieved. This is done to allow the liner to gradually settle on the sewer walls.

- After achieving 50 mbar, 100 mbar and 150 mbar, a wait time of 5 minutes is used before the pressure is increased again.
- In winter, the calibration times have to be increased significantly, as the viscosity of the resin is lower. We recommend doubling it.
- After 150 mbar, the pressure is increased until the maximum permissible pressure (see data sheet) in 100 mbar steps.
  After each additional increase in pressure of 100 mbar, the pressure is maintained for a wait time of five minutes.

- After achieving the operating pressure the curing cable is retracted until the light source is at the packer in the draw-in shaft.
- Now, press reset on the distance meter to zero the display [see **Fehler! Verweisquelle konnte nicht gefunden werden.**]
- Mark the curing cable with a strip of light-coloured tape 10 cm from the curing arm of the cable drum [see **Fehler! Verweisquelle konnte nicht gefunden werden.**]. This way, during the liner curing process it can be determined, independent of the distance meter, when the light source has reached the packer in the draw-in shaft.

Fig. 54 Tape marking on curing cable

Fig. 55 Distance meter reset

- After achieving the operating pressure, the light source is retracted from the draw-in shaft to the winding shaft. Pull the light source slowly and smoothly. If one is available, the light-source draw-in aid can be used.
- The drawing in procure should be observed using the monitor. This makes it possible to ensure that the liner is free of wrinkles. This step must be recorded on video!
- Shortly before the light source arrives at the packer in the winding shaft (about 0.5 – 1 m before this point), stop the draw-in aid and pull the remaining section to winding shaft by hand. Switch the draw-in aid to idle.
- Pressure adjustment (if necessary) to the recommended operating pressure (see data sheet)

After the final pressure has been reached, the UV lamp should only be switched on when the pipe liner is optimally aligned with the pipe wall.

Caution: All workers must have left the shaft before the liner is pressurised (> 100 mbar). The packers must be properly installed in the shaft areas with the tie down straps attached securely.

Fig. 56 Installed packer

6.17 SPECIFICS DURING INSTALLATION

6.17.1 DEFECTIVE INNER FOIL AND PRESSURE DROP

The inner foil may be damaged if a drop in compressed air is identified or if it is not possible to establish or maintain the corresponding pressure. In this case the external foil at the area with supporting caps will be inflated. A strong smell of styrene is noticeable through the relief cut. Air is input into the hose material as a result of a hole in the inner foil and this may lead to a leak in the liner. This is also evident on curing camera images by large white stains. In this case, it is paramount to install a replacement inner foil. Stop the installation if this is no longer possible.

A description for the installation of a replacement inner foil is available from Brandenburger. A technician of Brandenburger should be contacted prior to such an action.

6.18 CURING OF THE LINER

The drawing-in speed of the light source depends on:

1. The number of lamps and thus the length of the light source
2. The wattage (400 W, 600 W, 1000 W)
3. Distance of the lamps to the laminate (the lamps are not typically centred in the pipe)
4. Age and condition of the lamps and the time needed until the lamps reach their full intensity
5. System used and lamp type (double glass envelope, etc.)
6. Size of the shadow field (light-source type)

7. Size of the shadow field (DN <250, as in smaller pipes there is less scattered light and the shadow is sharper.)
8. Initial temperature of the liner
9. Liner environment (foreign water, pipe material, etc.)
10. Temperature is measured depending on the curing system type at the light sources (multiple temperature sensors, documentation of curing log)

Determination of the draw-in speed:

The firing intervals of the individual lamps and the draw-in speed of the individual light sources are to be selected according to the curing table of the corresponding system. It is available on the Brandenburger Liner Homepage.

The drawing-in speed is a guide value for starting the process. The drawing-in speed must be slowed down if the continuously measured process temperature on the inner wall of the liner falls below 80°C. An ideal value is a continuous 100-140°C. In certain cases, such as for liners with a small wall thickness (e.g. 3 mm), 80°C may not necessarily be reached - this applies in particular in damp conditions. In this case, 70°C can be assumed as a sufficient reference value for the temperature without qualitatively affecting the curing result.

Also refer to system-specific tables for the curing speed in oval sections. In the event of V-shaped and special-purpose profiles, use the replacement diameter (dimensions on delivery slip) and adapt the application technology.

Shortly before reaching the draw-in shaft (tape marking is at street level and curing arm visible), the speed is reset to zero

Fig. 57 Tape marking

For reasons of safety, manually pull the light source according to the curing speed until it is at the packer

Fig. 58 Light source, pulling by hand

Fig. 59 Light source, at the packer

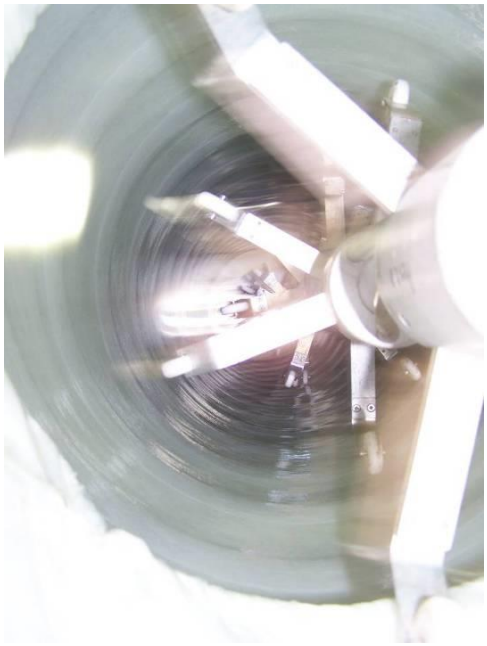
7 FINALISATION

Run the condenser/compressor after turning off the UV lamps to let the liner cool down until the highest temperature measured by the light-source temperature sensors drops below 80 °C. This is absolutely necessary to ensure that the inner foil separates securely from the laminate. Only then can logging be ended.

Remove the packer in the draw-in shaft and winding shaft.

After shutting off the air supply, remove the packer cover and cut the liner ends with a cutter knife in the draw-in shaft and winding shaft.

Fig. 60 Splitting the liner



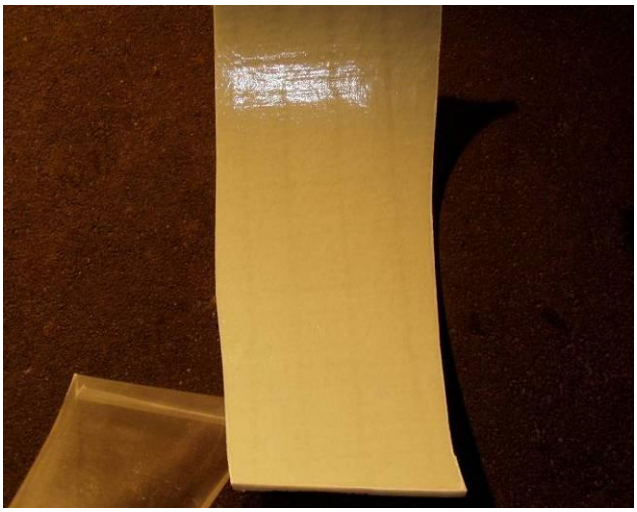
Pull the light source from the liner and hand it to someone to remove it from the shaft (Use gloves as the light source is very hot!). Secure the curing rope in the shaft.

Fig. 61 Removing the light source

Cut the liner flush with the shaft wall at the start of the sewer pipe using an angle grinder (in the draw-in and winding shafts) or leave edge for integration.

Take reference sample from the area of the previously set support caps.

Fig. 62 Cutting the liner flush



Clearly label the reference sample, pack it in a lightproof container and hand it over to the builder or store it

Fig. 63 Reference sample (information size, see 7.3)

To achieve a clean, fine cutting edge, we recommend using a fine diamond grinding wheel.

7.1.1 REMOVING THE INNER FOIL

Loosen the inner foil in the draw-in shaft from the liner interior surface

Fig. 64 Loosening the inner foil

Fig. 65 Inner foil secured to the curing rope

Fig. 66 Inner foil with safety rope

Fig. 67 Removal of the inner foil

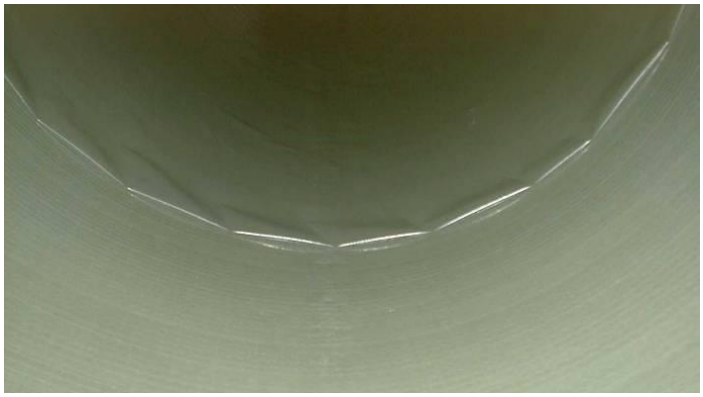


Fig. 68 Removal of the inner foil - Details

Once the beginning of the inner foil has reached the winding shaft, make an approx. 20 cm cut in the inner foil and cut the nylon safety rope inside.

Fasten the safety rope in this position in the draw-in shaft, and pull out the inner foil completely in the winding shaft.

Should the inner foil in the liner tear unexpectedly, the safety rope can be attached to the other end of the foil at the winding shaft, and the inner foil can be pulled out at the draw-in shaft as described above.

If the client requires a leak test (in acc. with DIN EN 1610), this can now be done.

If the conduit has intermediate shafts, these can now be cut open using an angle grinder. If no lateral inlets flow into the intermediate shaft, experience has shown that only the top half (half-shell) of the liner needs to be removed.

7.1.2 SHAFT CONNECTION/ TV ACCEPTANCE INSPECTION

The pipe liner ends and the pipe liner base half-shells in the intermediate shafts are infiltration-proof sealed with suitable methods; a TV acceptance inspection is typically performed upon completion.

Fig. 69 Shaft connection

7.2 OPEN INLETS, DISCONNECT WATER PUMP SYSTEM

Before opening the inlets, perform a leakage test

Use a milling robot to open pre-measured inlets sealed by the liner.

Remove all stop valves and reduce the water drainage.

7.3 SAMPLING

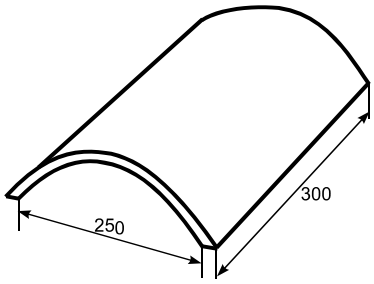


Fig. 70 Size of reference sample (in mm)

7.3.1 SAMPLE FROM SHAFT

The reference sample should be taken from the area where the support cap was installed. The reference sample piece must not display any marks left by the support cap sealing or the required test data may be inaccurate. The size should be 250 x 300 mm (size of a DIN A4 sheet).

If the conduit to be rehabilitated has one or more intermediate shafts, it is also possible to take reference samples from these shafts. Here, a support cap is also required for sample-taking.

7.3.2 SAMPLE FROM CONDUIT

To obtain a sufficiently sized and usable sample from conduits that do not contain intermediate shafts, or in the case of restricted space in the area around the packer, the sample can be taken directly from the rehabilitated conduit after consultation with the client (check in advance for groundwater pressure). The sample should be taken from a section with a level floor and, in case of a circular profile, from the apex area because of the stress characteristics of pipes.

7.3.3 OVAL PROFILE

As it is not possible to take a representative sample of oval profile shafts from the packer area or an intermediate shaft, the sample must always be taken from the rehabilitated conduit. The sample is always taken from the area around the springer with a level or pre-prepared base.

Landau, 9 February 2022

8 ENCLOSURES

8.1 MATERIAL DESCRIPTION

For the Brandenburger Liner BB$^{2.5}$ / BB$^{2.0}$ a corrosion-resistant ECR/Advantex glass fibre is used as reinforcement material.

The Brandenburger BB$^{2.5}$ / BB$^{2.0}$ Liner is produced and distributed with the DIBt-Certification Z-42.3-490.

The static characteristic values are listed in the data sheets of the respective type.

For impregnating the glass-fibre complexes it is used a standard UP-resin, acc. to **DIN 16946** type 1140 and EN13121 group 4, **as well as VE resin, acc. to DIN 16946 Type 1310 or EN 13121 Group 7A.** The application of the Brandenburger BB$^{2.5}$ / BB$^{2.0}$ Liner is oriented around the expected chemical and temperature-dependent strain; this is determined by the client.

Landau, 9 February 2022

Brandenburger BB$^{2.5}$ / BB$^{2.0}$ Liner

1- **Internal pipe foil** (PA / PE)

2- **Glass-bonded pure resin abrasion layer**

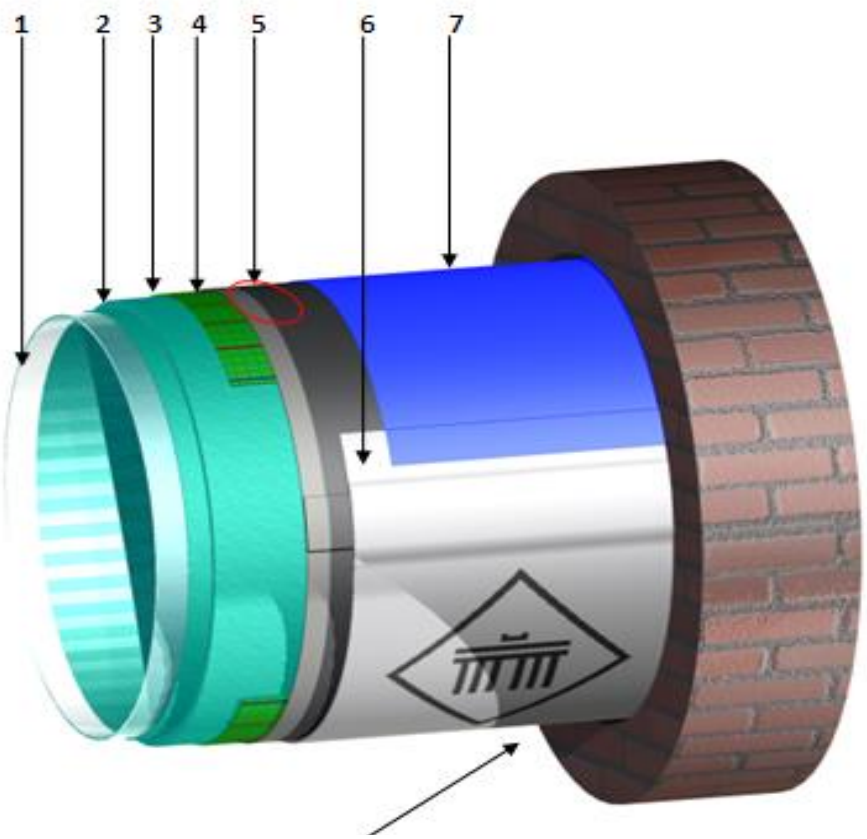
3- **Supporting laminate** (reaction resin + ECR-glass fibre reinforcement)

4- **Fabric pull cables** (in the area of apex and base)

5- **Fabric-line external foil** (PE-fabric / PE / PA / PE)

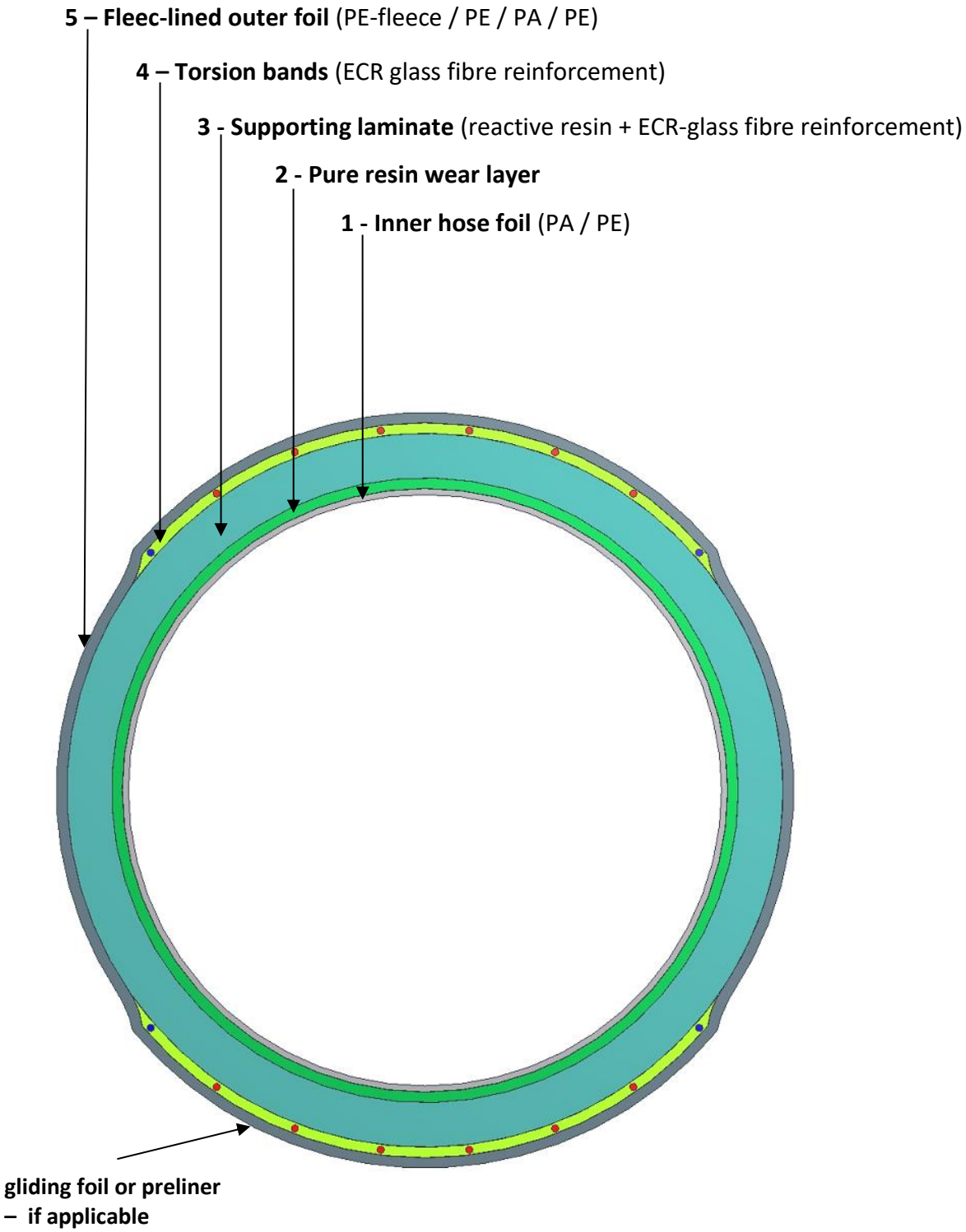
6- **Reinforced fabric foil** (additional external protection = AP)

7- **Fixing adhesive tape** (expansion gap)

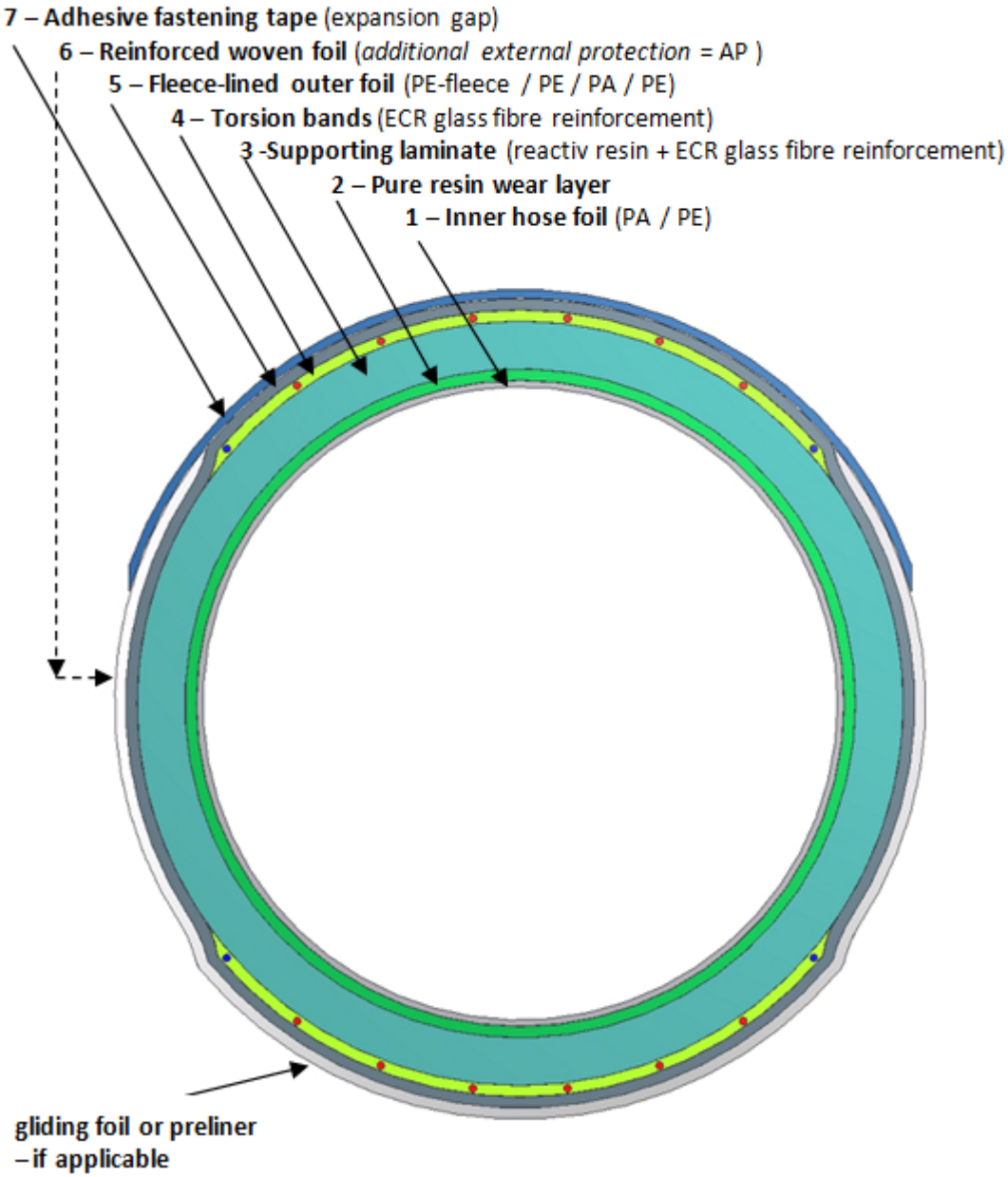


gliding foil or preliner – if applicable

variant 1


5 – Fleec-lined outer foil (PE-fleece / PE / PA / PE)
4 – Torsion bands (ECR glass fibre reinforcement)
3 - Supporting laminate (reactive resin + ECR-glass fibre reinforcement)
2 - Pure resin wear layer
1 - Inner hose foil (PA / PE)
gliding foil or preliner
– if applicable

variant 2


7 – Adhesive fastening tape (expansion gap)
6 – Reinforced woven foil (additional external protection = AP)
5 – Fleece-lined outer foil (PE-fleece / PE / PA / PE)
4 – Torsion bands (ECR glass fibre reinforcement)
3 -Supporting laminate (reactiv resin + ECR glass fibre reinforcement)
2 – Pure resin wear layer
1 – Inner hose foil (PA / PE)
gliding foil or preliner
– if applicable

Liner with the additional external foil

Folded Liner
after production.

Positioning of the Liner
into the shaft.

8.2 NOTIFICATION FOR LOCAL RESIDENTS

To the residents

of the estate

Sewer rehabilitation with GFRP pipe liner on behalf of the municipality

Starting on .....

urgently necessary sewer rehabilitation work will be performed in your street. We kindly ask that in this time you use as little water (e. g. washing machine, bathtub, shower, WC, etc.) as possible, as your house connections will be closed for approx. 8 – 10 hours and a build-up could occur. During the rehabilitation process, it may be necessary to check your inspection shaft, so please keep it accessible for this purpose.

Due to the high-pressure cleaning performed beforehand, it **may** be possible that your traps of the floor drains can be emptied due to the "suction effect" of the high-pressure cleaning. Please fill them with water again to avoid unpleasant odours due to the wastewater sewer and the polyester resin used during the rehabilitation process.

Rehabilitation in this so-called "closed construction" method is used increasingly, as it can be performed more quickly and the sewers can be renewed from the existing inspection shafts for the most part without excavation and the associated prolonged inconvenience from the noise and dirt.

For the process that we use, a glass fibre tube, impregnated with a polyester resin, is drawn into the sewer, "blown up" with compressed air and then cured using UV light. The polyester resin that we use has a very low odour threshold and has a very strong odour during the curing period. Nonetheless, no harmful concentrations are reached during the installation.

If you have any other questions (regarding the technology or exact schedule), please contact our foreman on the construction, Mr./Ms. ……..

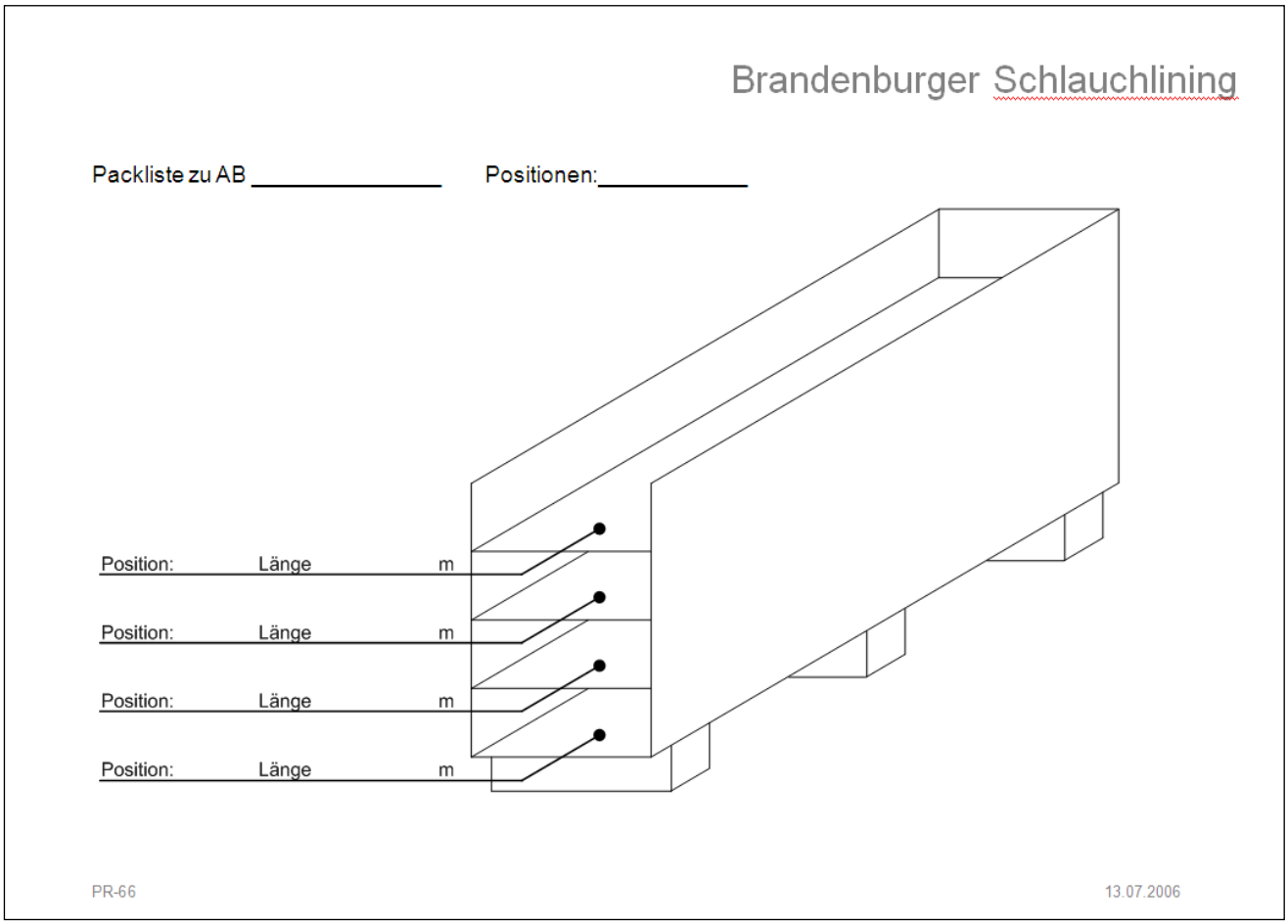
Best regards,

8.3 DIRECTORY OF WASTE CODES

Used wood (liner crate)	AVV 150103
Resin residue (e. g. uncured liner pieces)	AVV 070208
Mixed packaging (e. g. cured liner residue, dirty foil remnants, etc.)	AVV 150106

Landau, 9 February 2022

8.4 LINER PACKING LIST



9 LIST OF FIGURES

10 INDEX

11 NOTES

Brandenburger Liner GmbH & Co. KG
Taubensuhlstr. 6
D – 76829 Landau
Tel: (+49) (63 41) 51 04-0
E-mail: info@brandenburger.de
www.brandenburger.de

Landau, 9 February 2022