

Process Instructions

Rehabilitation process **BRAWOLINER**®

Light Curing



Valid from: 05/2023

Please retain for future use!

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1.0.0 Introduction

These process instructions and the operating and maintenance instructions of the machines and devices used must always be available for the operators/maintenance personnel. They contain important instructions on carrying out the inversion process **safely and properly**.

The objectives of these process instructions are:

- to be familiar with the inversion process
- to use the inversion process as intended
- to install the **BRAWOLINER**® properly

Observing them guarantees:

- the safety of the operating personnel
- the prevention of hazardous conditions (work accidents)
- the problem-free operation of the inversion accessories.

BRAWO® **SYSTEMS GmbH** assumes no liability for damage and operating malfunctions resulting from non-compliance with these process instructions.

2.0.0 Safety - accident prevention

2.1.0 Warning instructions and special details

The following designations are used for safety instructions and details in these process instructions:

DANGER!



Indicates an imminently threatening danger. Failure to follow instructions poses a risk of death or the most severe injuries.

WARNING!



Indicates a possibly hazardous situation. Failure to follow the instructions can result in severe injuries.

CAUTION!



Indicates a possibly hazardous situation. Failure to follow instructions can result in slight injuries.

ATTENTION!



Special requirements and prohibitions for loss prevention.

NOTE!



Specific details for economical use and important additional information.

2.2.0 Intended use

- The BRAWO® inversion drum is designed exclusively for the inversion of the **BRAWOLINER®** with a nominal diameter (unexpanded) of DN 50 (2 inch) to DN 300 (12 inch). Any other use beyond that specification is considered improper use! The manufacturer/supplier is not liable for any damage as a consequence. The risk is borne solely by the user.
- Included in intended use are observance of the operating manual of the device used, compliance with the inspection and maintenance conditions and observance of the safety instructions listed in these process instructions.
- The inversion process must only be used by persons trained and authorized for this and the equipment only operated, serviced and repaired by these persons.
- Always replace defective parts with original accessories from **BRAWO® SYSTEMS GmbH**. Only in this way is perfect operation of the machine/system ensured.

ATTENTION!



In case of faulty operation or improper use, there is the threat of risk to:

- **Life and limb**
- **Property**
- **The efficient working of the machine**

2.3.0 Improper use

No improper use is known.

2.4.0 Sources of danger – accident prevention

2.4.1 Residual risks

The machines and devices used in the inversion process are built to the newest state of technology and the recognized safety-related regulations. This presumes that corresponding work protection and accident prevention regulations are followed.

However, the following residual dangers exist when handling the:

- **BRAWO® Inversion drum**

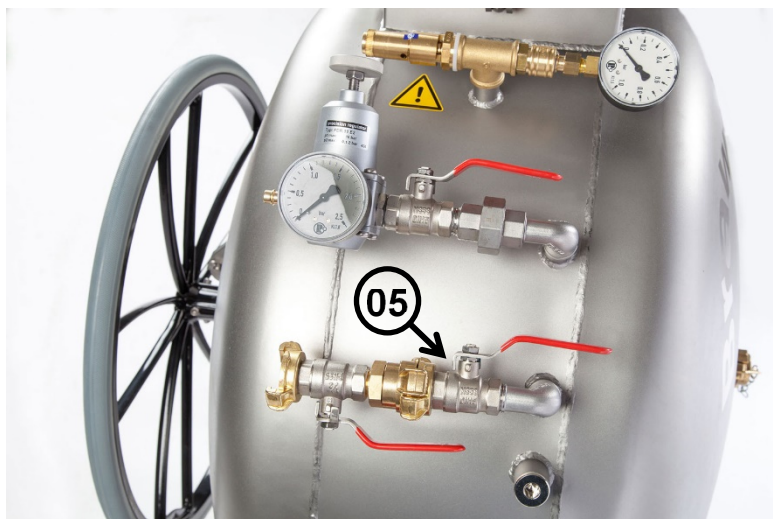
CAUTION!



DANGER OF CRUSHING!

Wear protective gloves in the area of the handwheel.

**In emergency situations release pressure:
Open “pressure release” ball valve pos. 05
– the system pressure escapes.**



- Vinyl ester resin

DANGER!



GHS 07



GHS 09



GHS 05



- *Causes severe eye damage*
- *Causes skin irritation*
- *Can cause allergic skin reaction*
- *Can irritate the respiratory system*
- *Toxic to water organisms with long-term effects*

⇒ **Always wear safety glasses and protective gloves.**

⇒ **Do not, eat, drink or smoke while working.**

⇒ **Do not inhale dust/smoke/gas/spray/aerosol. Ensure good ventilation during the entire work process.**

⇒ **Follow current safety data sheets.**

- Light curing system

DANGER!



- **UV RADIATION: Severe damage to the eyes due to UV radiation**
Protect the eyes from UV radiation using UV safety glasses.
Do not look into the light sources!
- **RISK OF SKIN BURNS!**
Protect with suitable clothing. Do not expose unprotected skin to UV radiation.

2.4.2 Personal protective equipment

When handling:

- BRAWO® Inversion drum

ATTENTION!



DANGER OF CRUSHING!
Wear protective gloves.

- Vinyl ester resin

ATTENTION!



CAUSTIC EFFECT / RISK TO HEALTH!

- Safety glasses with side shields or eye protection acc. to DIN EN 166
- Chemical-resistant protective overall
- Chemical-resistant protective gloves tested acc. to EN374, e.g. made of nitrile rubber.
- Wear filter mask type A, based on the danger and risk of an exposure.
- Observe current safety datasheet.

- **Piston compressor**

ATTENTION!



HIGH NOISE LEVEL!

Severe hearing damage possible. Wear ear protection.

- **Light curing system**

ATTENTION!

UV RADIATION!



- **Severe eye damage possible.**

Wear UV eye protection. This must comply with Welding Protection Class 5 and be certified acc. to DIN EN 166 “Personal eye protection” and DIN EN 169 “Filters for welding and related techniques”.



- **Protective clothing.**

2.4.3 First aid measures (vinyl ester resin)

- **General instructions:**

Vinyl ester resin can cause skin irritation and skin allergies. Therefore, avoid contact with the skin.

Immediately remove clothing contaminated with product. Poisoning symptoms can first show up after many hours, therefore medical monitoring at least 48 hours after an accident.

- **After inhaling:**

Contact a physician immediately. Ensure ample fresh air supply. If unconscious, place in a stable side position, also for transport. Keep airways open and facilitate breathing.

- **After contact with the skin:**

Contact a physician immediately. Wash with soap and water immediately and rinse well. Remove contaminated clothing and shoes. Do not use thinner or solvent to clean the skin.

- **After contact with the eyes:**

Contact a physician immediately. Rinse eyes with opened lids a minimum of 10 minutes under flowing water or use eye rinse solution. If wearing contact lenses, remove them.

- **After swallowing:**

Contact a physician immediately. Rinse mouth with water. Drink water in small amounts and ensure fresh air supply. Do not induce vomiting!

For more details refer to the BRAWO® resin safety sheets.

In urgent cases contact the poison control center of the Mainz University Clinic:



National poison emergency center:

0 6131 19240

International poison emergency center

(+49) 6131 19240

2.4.4 Safety equipment

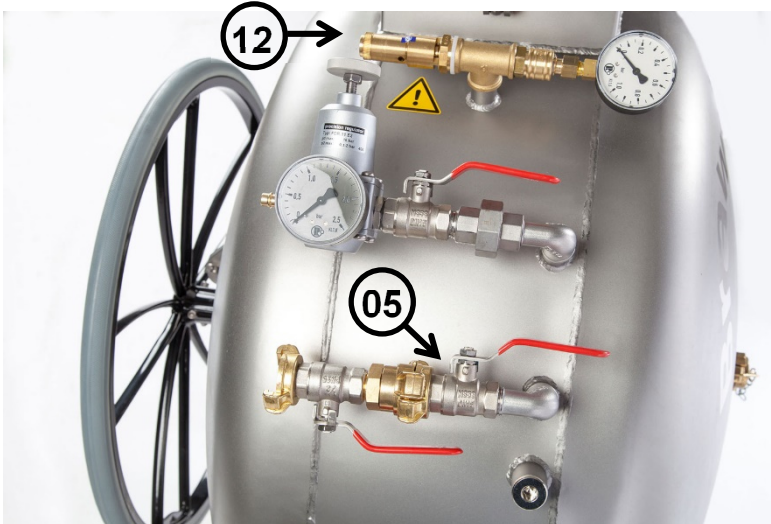
ATTENTION!



- Operation without intact safety equipment protective devices is not permitted.
- Safety equipment must not be taken out of operation or modified.
- It is prohibited to operate the BRAWO® inversion drum with technical deficiencies.
- It is prohibited to operate the light curing system with technical deficiencies.
- Release the pressure and disconnect all auxiliary devices from the BRAWO® inversion drum before service, repair and maintenance work.

BRAWO® SYSTEMS

A safety valve is installed on the BRAWO® inversion drum as safety device (Pos. 12). This opens at 0.9 bar. In emergency situations release pressure: Open “pressure release” ball valve pos. 05 – the system pressure escapes.



2.5.0 Work place and worker ability

The work stations of the operators are defined in the respective operating manuals of the various machines and devices.

The operating company is responsible for assigning personnel that have been introduced to the **BRAWOLINER®** by **BRAWO® SYSTEMS GmbH**, to materials being used and corresponding integrated equipment. Training is confirmed with a certificate and is personally handed out to each participant. Only these specially trained personnel may be used for the inversion process and during the curing with the light curing system.

2.6.0 Noise Emission

The A-weighted equivalent continuous sound pressure level of the BRAWO® inversion drum, the BRAWO® impregnation system, the light curing system and the vacuum pump are below 70 dB(A).

When using a piston compressor values can reach above 85 dB(A). Set the piston compressor outdoors.. If the piston compressor must be set near operating personnel due to construction, the operators must wear ear protection.

Values of above 85 dB(A) can also be reached when gaseous media is escaping out of openings. Operating personnel in the immediate area must wear ear protection.

ATTENTION!



HIGH NOISE LEVEL!

Severe hearing damage possible. Use ear protection.

3.0.0 Installation process - Description of the process

This section is used for general information about the **BRAWOLINER®** rehabilitation process and should give the user important background knowledge.

3.1.0 Area of application

The **BRAWOLINER®** light curing system covers the trenchless rehabilitation of house connection lines. Channels and piping systems in the dimensions of DN 100 to DN 300, also with bends and dimension changes, can be rehabilitated.

3.2.0 Brief description of the BRAWOLINER® inversion process

Damaged piping systems must be prepared appropriately (cleaned, etc.) before inversion. The **BRAWOLINER®** is impregnated with vinyl ester resin. The resin is evenly distributed over the entire length of the CIPP with the BRAWO® impregnation system.

- **Installation with BRAWO® inversion drum (compressed air)**

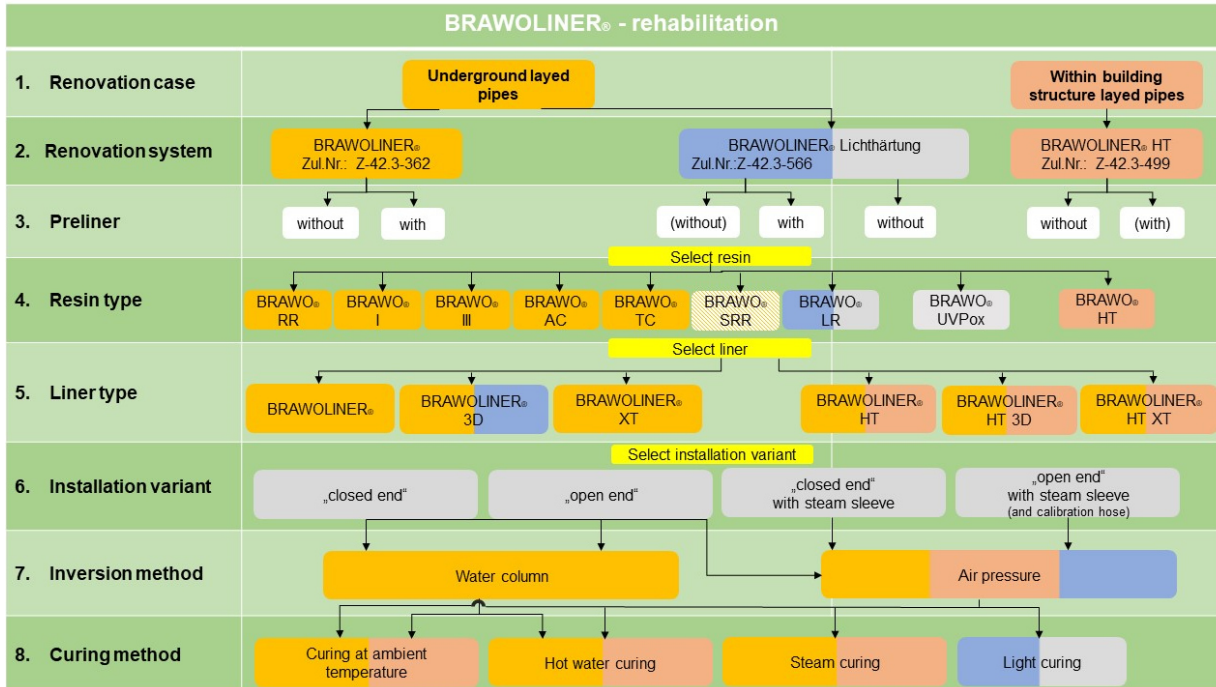
The pretreated **BRAWOLINER®** is placed in the BRAWO® inversion drum and inverted into the damaged pipe using compressed air.

This places the **BRAWOLINER®** against the existing pipe walls.

The light curing system cures the vinyl ester resin using light.

After curing, the rehabilitation section should be checked with a camera.

3.3.0 Schematic flow



The above decision matrix is used for an overview of all possible **BRAWOLINER®** rehabilitation variants.

The contents of the individual steps are explained in detail in the following subsections, and help in the selection of the suitable variant in individual cases.

Follow the respective process instructions for the rehabilitation of the epoxy resin systems BRAWO® RR, BRAWO® I, BRAWO® III, BRAWO® AC, BRAWO® TC or BRAWO® HT.

3.3.1 In the case of rehabilitation

If rehabilitation is possible using a CIPP liner, the following information should be available for planning the rehabilitation. These should, for example, be determined with the aid of a camera inspection after cleaning the lines.

- Placement location of the lines (underground/in house)
- Old pipe material
- Maximum temperature load of the line
- Increased chemical load of the line? (industry)
- Damage pattern (large wall breakouts present / possible static function of the liner necessary?)
- Line length
- Nominal diameter
- Nominal diameter changes
- Line routing / bends
- Number / position of the inlets
- Access options (one side / two sides?)
- Height difference between the beginning and end of the rehabilitation section

3.3.2 Rehabilitation system

BRAWOLINER® system

The **BRAWOLINER®** system enables the rehabilitation of underground damaged waste water lines *outside of* or *under* buildings.

3.3.3 Preliner

NOTE!



- A preliner must be inserted in advance of the rehabilitation in zones saturated with groundwater (ground water infiltration).

A preliner is a polyethylene (PE) CIPP film in the nominal diameter of the old pipe to be rehabilitated. The preliner is inverted with open end and collapsed. The beginning of the preliner is fixed on the old pipe, then the **BRAWOLINER®** is inverted in the preliner.

For more detail on the installation process, refer to the [section 4.1.3 “Inverting the preliner”](#) on [page 32](#).

3.3.4 Resin type

The light curable vinyl ester resin BRAWO® LR is used during rehabilitation in the curing process with the **BRAWOLINER®** light curing system.

The processing instructions, required resin quantity and roller distances can be found in the **section 7.0.0 “Things to know about reaction resins”** starting on **page 77**. For detailed information on resin, refer to the datasheets.

3.3.5 Liner types

Depending on the rehabilitation case, a wide variety of requirements occur for the rehabilitation system. These can be met with the following liner types.

Liner types and field of application												
BRAWOLINER [®] Liner type	Liner Name	sealing Function	Special static function	underground pipes	Ø 100	Ø 120	Ø 150	Ø 175	Ø 200	Ø 225	Ø 250	Ø 300
BRAWOLINER [®]	DN 70/80	X		X								
	DN 100	X		X	X ^{*)}							
	DN 125	X		X		X	X					
	DN 150	X		X			X	X				
	DN 200	X		X					X	X		
XT	DN 100	X	X	X	X ^{*)}	X						
	DN 125	X	X	X		X	X					
	DN 150	X	X	X			X	X				
	DN 200	X	X	X					X	X		
3D	DN 70-100	X		X	X ^{*)}							
	DN 100-150	X		X	X ^{*)}	X	X					
	DN 150-225	X		X			X	X	X	X		
	DN 200-300	X		X					X	X	X ^{*)}	X ^{*)}

*) recommended only when used with LED head_Mega_192

**) recommended only when used with LED head_Nano_96

For light curing, the use of **BRAWOLINER[®]** DN 50 and **BRAWOLINER[®]** 3D DN 300-400 is not recommended.

The following installation and curing pressures are recommended for the various liner types:

Liner type	Inversion pressure (bar)	Curing pressure (bar)	Curing pressure with calibration CIPP (bar)
BRAWOLINER [®] / XT	approx. 0.2	approx. 0.4 - 0.5	min. 0.4
BRAWOLINER [®] 3D	approx. 0.3	approx. 0.4 – 0.5	min. 0.4

NOTE!



- The values given in the table are recommended; geometry and routing of the rehabilitation section may possibly require other pressures. The instructions on [page 29](#) must also be followed for this.
- When curing in the largest dimension, especially with BRAWOLINER[®] 3D, it must be ensured that the liner lies against the pipe wall.

3.3.6 Installation variants

There are 2 variants to design **the ends** of the **BRAWOLINER[®]**, which are dependent upon the accessibility of the line end.

For detailed instructions for designing the knots, refer to the [section 4.1.6 “Close the BRAWOLINER[®]”](#) starting [page 38](#).

3.3.6.1 Calibration CIPP

The calibration CIPP is a translucent, coated braided CIPP, which can be inverted into the **BRAWOLINER[®]** after this is inverted. It is used for setting up the liner when installing with an open end.

Due to the occurring reaction temperature, it must be ensured that a temperature-resistant calibration CIPP is used.

For more detail on the installation process, refer to the [section 4.2.9 “Inverting the calibration CIPP”](#) on [page 65](#). For detailed information on the calibration CIPP types, refer to the datasheets.

3.3.6.2 Installation variant “closed end”

Application with:

- **BRAWOLINER[®]** end accessible
- **BRAWOLINER[®]** end **not** accessible, milling robot required

This is the most common inversion method. No additional effort is required to maintain the contact pressure in the pipe. The end of the **BRAWOLINER[®]** is opened after curing of the resin with the aid of a suitable tool.

Type of structure:

- ⇒ “Closed end” **BRAWOLINER[®]**
- ⇒ No calibration CIPP required
- ⇒ Fasten retaining strap (and possibly holder cup, e.g. for BRAWO[®] Magnavity) on the end of the **BRAWOLINER[®]**

3.3.6.3 Installation variant “open end”

Application with:

- **BRAWOLINER[®]** end **not** accessible

This variant is used if there is **no** possibility to open the **BRAWOLINER[®]** on the end after the rehabilitation. This variant is more complicated to perform, since after the inversion of the **BRAWOLINER[®]** a calibration CIPP must also be inverted in order to maintain the contact pressure in the pipe.

Type of structure:

- ⇒ “Open end” **BRAWOLINER[®]**
- ⇒ “Closed end” calibration CIPP
- ⇒ Fasten retaining strap (and possibly holder cup, e.g. for BRAWO[®] Magnavity) on the end of the calibration CIPP

3.3.7 Required installation equipment

Necessary equipment:

1. Compressor
2. Power generator (approx. 3 kW), alternatively power supply 230V
3. Rechargeable screwdriver
4. Inspection camera

BRAWO® SYSTEMS

Always required:

1. **BRAWOLINER®**
2. Vinyl ester resin BRAWO® LR
3. Vacuum pump
4. Duct tape
5. BRAWO® Impregnation system (electrical or manual)
6. BRAWO® Inversion drum (compressed air) with an airlock for light source
7. Light curing system, e.g.: **BRAWO® Magnavity** system consisting of control unit, retraction unit and reel with CIPP package and LED head Nano_96 or Mega_192

Optionally required:

1. Preliner
2. Calibration CIPP
3. Climatic cabinet for temperature control of the resin
4. Connection collars
5. BRAWO® VortexCutter
6. BRAWO® rehabilitation trailer or van for carrying all accessories



Equipment and consumables for rehabilitation can be ordered as individual components, up to the complete package from **BRAWO®SYSTEMS GmbH**.

More detail can be found under: www.brawosystems.com

3.3.8 Curing process: Curing with light

Curing of resin is done through chemical reaction, which is started by light. For more detail, refer to **section 7.0.0 “Things to know about reaction resins”** on **page 77**.

A light curing system is used for curing with light. The light source is inverted or pushed together over the airlock on the inversion nozzle up to the end of the liner. Then the CIPP / pushrod is placed in the retraction unit and the retraction speed set on the control unit. Finally the light source is turned on and the retraction started. When the light source has reached the inversion nozzle, the retraction is stopped and the light source turned off.

Description of components of the light curing system:

The light curing system consists of the components

- Control unit
- Retraction unit
- Light source with CIPP package/pushrod
- Lock

Control unit:

The control unit normally consists of a monitor to display the video image, a control panel with the control elements and a display for showing the set parameters as well as the measurement values of the process.

Displayed, for example, are the temperature of the light source and air temperature, target and actual values for the retraction speed and pressure, as well as the already traveled distance.



Example of a control unit LED system (BRAWO® Magnavity)



Example of a control unit gas discharge system (BRAWO® LumCure)

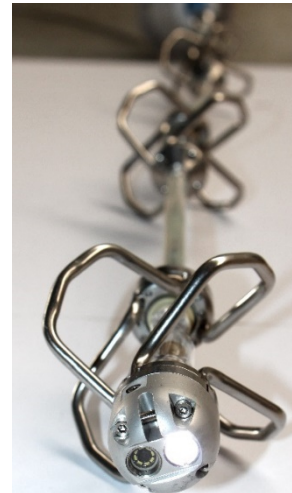
Light source with CIPP package/pushrod and reel:

A light curing system possibly contains several light sources for various pipe diameters. For the BRAWO® Magnavity there are, for example, the LED head Nano_96 and Mega_192 available. Depending on the selected nominal diameter, the size of the LED head is to be selected corresponding to the table on [page 20](#).

As a rule there is a camera with suitable illumination located on the front end. A temperature sensor for recording the air temperature in the liner, as well as an infrared sensor for recording the temperature on the liner surface often also are in the equipment.



Example of a light source LED system (BRAWO® Magnavity LED head Nano_96 and Mega_192)



Example of a light source gas discharge system (BRAWO® LumCure)

Retraction unit:

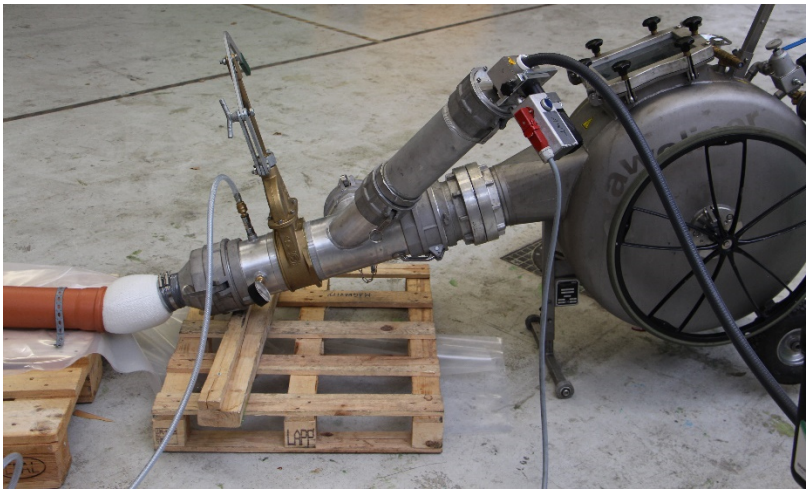
The retraction unit is used for pulling back the CIPP package/pushrod during the curing. It contains the drive wheels and if necessary a measuring wheel to monitor the retraction speed.



Example of a retraction unit (BRAWO® Magnavity)

Lock:

Through the use of the Y-airlock with spool valve, two independent pressure areas are formed. In the area to the liner the interior pressure is maintained during the entire inversion process in the liner. In the area at the drum it can be worked without pressure during this. In this pressureless area thus after half of the inversion of the liner, the LED head of the BRAWO® Magnavity can be coupled with the holder cup, which was previously fastened on the liner knots.



Example of Y-airlock BRAWO® Magnavity



Example of an airlock (with connected retraction unit)

4.0.0 Installation process – Guidelines

4.1.0 Installation with closed end

In these process instructions the **BRAWOLINER[®]** process for the **house connection rehabilitation** (**BRAWOLINER[®]** system) is treated with light cured vinyl ester resin.

ATTENTION!



- The installation must only be carried out by trained specialist personnel.
- Pay special attention to the **section 2.0.0 “Safety - accident prevention”** on **page 5**.
- The installation direction is as a rule in the direction of flow (with the downward gradient).
- In case of in situ ground water, the installation pressure must be around 0.4 bar above the possible ground water pressure. The installation of a liner is possible up to a ground water level of 4 m.
- Do not set an installation pressure > 0.8 bar in any case.
- The installation recommendations for inversion and curing pressure for the individual liner types on **page 20** must be observed.
- The following described installation process is oriented to a normal case. Deviations can be caused by conditions on site and must be recognized by the specialist personnel.

NOTE!



- The *section 4.0.0 “Installation process – Guidelines”* is structured in steps. The sequence listed here must absolutely be complied with.
- The rehabilitation is to be documented. For this also refer to *section 7.4.0 “Curing speeds”* on *page 80* and *section 8.0.0 “Installation Protocol”* on *page 81*.

4.1.1 Preparation of the line to be rehabilitated

NOTE!



The foundation must be clean and free of all loose parts, dust, oil, grease or other substances that could have a negative effect on adhesion. It can be dry or damp. The foundation must be capable of carrying the load and have a generally required tear strength of min. 1.5 N/mm².

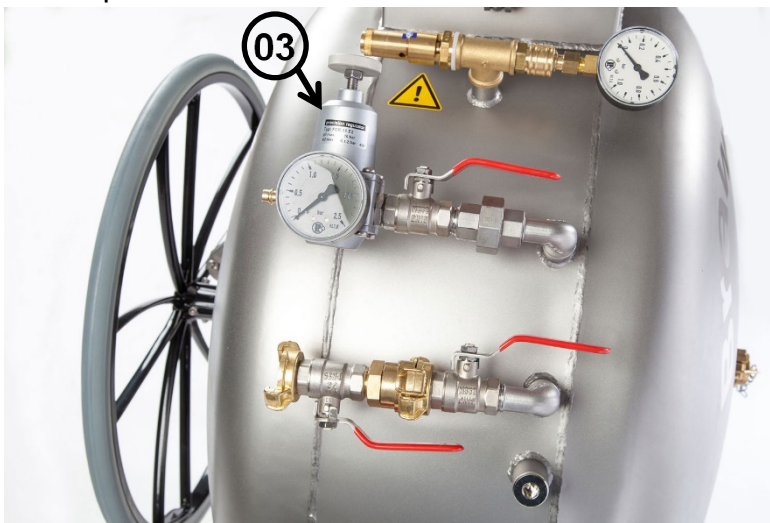
1. High-pressure cleaning of the line to be rehabilitated
2. Pictures of damage using inspection camera.
3. Remove all hindrances, for example with a milling robot. Protruding hindrances can damage the **BRAWOLINER[®]** during installation.
4. Establish the length of the rehabilitation section, record the pipe diameter and calibrate.
5. Calibrate all supply lines. During the rehabilitation of pipe lines with dimensional offsets or with the use of a calibration CIPP, the exact positions of the supply lines must be determined, since the bulges here can be less pronounced here.
6. If necessary there is the possibility to install a preliner beforehand, see the *section 4.1.3 “Inverting the preliner”* on *page 32*.

7. Make sure that during the rehabilitation that no waste water is introduced. Block storm water inlet, if necessary.

4.1.2 Establishing operational readiness

BRAWO® Inversion Drum

1. Put the BRAWO® in inversion drum in position. Make compressed air connection on the pressure control valve Pos. 03.



2. Make sure that all ball valves are closed.
3. Have the correct inversion pipe, airlocks for the light curing system, inversion CIPP and Storz CIPP coupling wrench ready.
4. Pull in the retractable cable (for pulling through the liner later).
5. Fasten the retaining cable with one end on the drum reel and wind several layers around the axle. Be sure to have an adequate length of the retaining cable.
6. Have ready the correct CIPP clamps, cable ties, adhesive tape and rechargeable screwdriver.
7. Ensure power supply.
8. Prepare BRAWO® impregnation system.
9. Move the light curing system in operational readiness.

10. Check the functionality of the installation equipment.

4.1.3 Inverting the preliner

CAUTION!



DANGER OF CRUSHING!

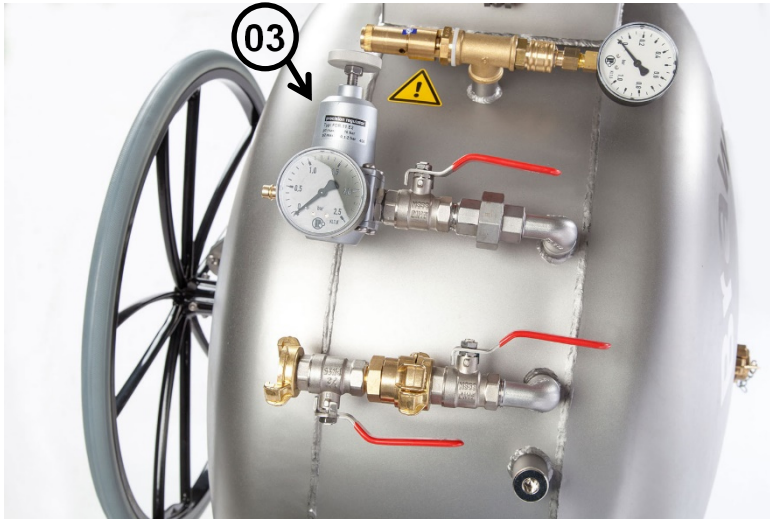
Wear protective gloves in the area of the handwheel.

The required length of the preliner is made up of the following factors:

Rehabilitation length + addition for fastening on the inversion pipe

1. Wind up the preliner with the open end on the drum axle. Do not connect the end of the preliner with the retaining strap!
2. Push through the beginning of the preliner with the aid of the retractable cable, inversion nozzle, inversion CIPP and the corresponding inversion pipe.
3. Invert the beginning of the preliner on the inversion pipe and fasten with at least two CIPP clamps.
4. Align the inversion pipe to the pipe to be rehabilitated (2nd operator).

5. The 2nd operator gives the signal to start. Then the 1st operator (is positioned on the BRAWO® inversion drum) opens the compressed air inlet on the pressure control valve (Pos. 03). Normally inversion is done with a pressure of approx. 0.2–0.3 bar. Special conditions on site can require deviating pressures.



6. The inversion speed can be impacted by the pressure control valve (Pos. 03).
7. The inversion of the preliner is completed when the preliner has reached the end of the rehabilitation section (system pressure escapes).
8. Close the pressure control valve (Pos. 03).
9. Open the CIPP clamps on the inversion pipe and fasten the preliner on the shaft.

4.1.4 Cut the BRAWOLINER® to length, close and prepare for the impregnation.

$$\begin{array}{r} \text{Rehabilitation length} \\ + \text{ Addition for fastening on the inversion pipe} \\ + \text{ Addition for closing, vacuum and knots} \\ \hline = \text{ Length of the BRAWOLINER®} \end{array}$$

NOTE!



The BRAWOLINER® is a flexible liner. Too high an inversion pressure can cause the material to stretch.

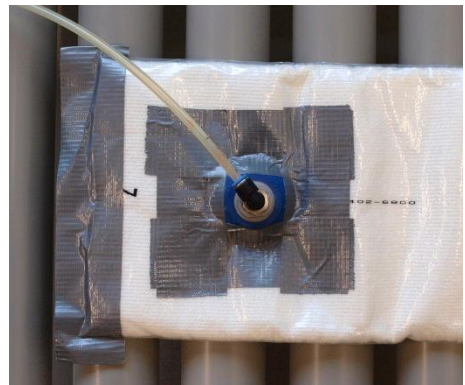
Lay out the BRAWOLINER® with no wrinkles.

1. Cut the BRAWOLINER® to length.
2. Lay out the BRAWOLINER® on the BRAWO® impregnation system. The imprinted arrow must always point from the roller strap in the direction of the impregnating roller.
3. Fold back a cuff at the beginning of the BRAWOLINER® (will also be used later for fastening on the inversion pipe) The imprinted arrow must always point in the direction of the cuff.



BRAWO® SYSTEMS

4. Close the end of the **BRAWOLINER®** airtight with an adhesive tape.
5. Make a cut of approx. 1-2 cm in the outer film at the end of the **BRAWOLINER®**.
6. Set the suction cup of the vacuum pump on this cut, if necessary fix with adhesive tape and suck the air out of the **BRAWOLINER®** with approx. 500 mbar vacuum.



4.1.5 Impregnating the BRAWOLINER®

DANGER! *Vinyl ester resin*



GHS 07



GHS 09



GHS 05



- *Causes severe eye damage*
- *Causes skin irritation*
- *Can cause allergic skin reaction*
- *Can irritate the respiratory system*
- *Toxic to water organisms with long-term effects*

- ⇒ **Always wear safety glasses and protective gloves.**
- ⇒ **Do not, eat, drink or smoke while working.**
- ⇒ **Do not inhale dust/smoke/gas/spray/aerosol. Ensure good ventilation during the entire work process.**
- ⇒ **Follow current safety data sheets.**

ATTENTION!

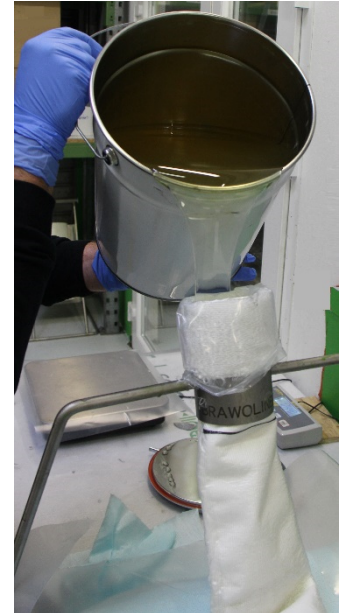


CAUSTIC EFFECT / RISK TO HEALTH!

- **Safety glasses with side shields or eye protection acc. to DIN EN 166**
- **Chemical-resistant protective overall**
- **Chemical-resistant protective gloves tested acc. to EN374, e.g. made of nitrile rubber.**
- **Wear filter mask type A, based on the danger and risk of an exposure.**
- **Observe current safety datasheet.**

BRAWO® SYSTEMS

1. Calculate the required quantity of resin. Refer to **section 7.3.0 “Resin”** on **page 79**.
2. Fill the resin in the **BRAWOLINER®**.
3. Fold back the cuff again on the fill end to prevent possible leakage of resin.
4. Distribute and work in the resin with the BRAWO® impregnation system. Select and set the roller distances corresponding to the **section 7.3.0 “Resin”** on **page 79**. Normally one to two rolling passes are necessary to impregnate the **BRAWOLINER®** evenly.
5. Check the length of the **BRAWOLINER®** if necessary.
6. The impregnated **BRAWOLINER®** is brought to the BRAWO® inversion drum.

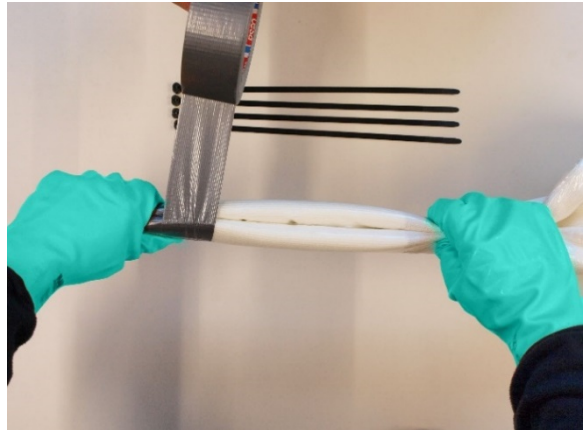


4.1.6 Close the BRAWOLINER® end

1. Close the end of the **BRAWOLINER®** airtight.



2. Fold the **BRAWOLINER®** lengthwise and wrap up with adhesive tape.

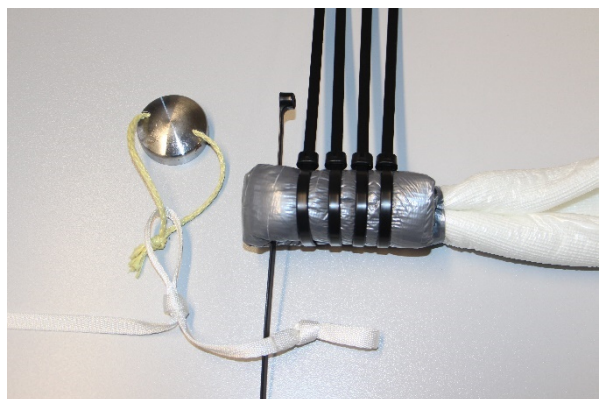


When using BRAWO® Magnavity

3. Fasten the holding cup CIPP on the retaining cable. The distance between the holder cup and liner end should not be greater than 5 cm!



4. Place a cable tie in the knot for fastening on the holder cup CIPP.



5. Cut the protruding tip of the cable tie as short as possible to prevent damage, tape over the cable tie.



6. Completed knots



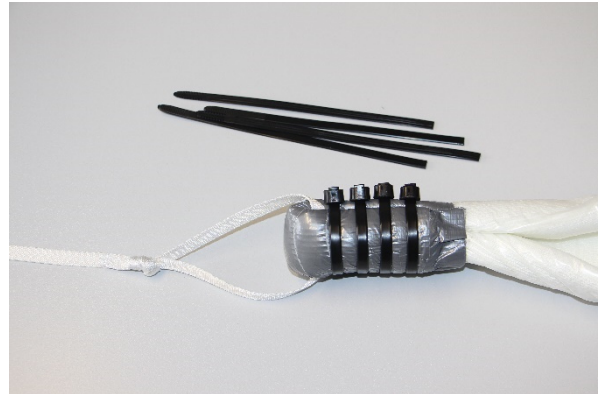
Comment: For **BRAWOLINER®** 3D DN 200-300 the use of four CIPP clamps is recommended instead of cable ties.

With the use of another light curing system

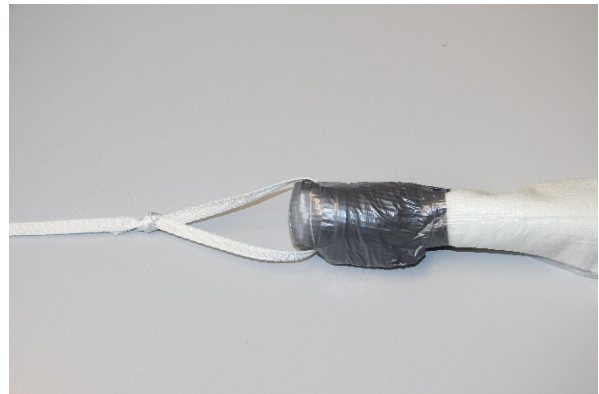
- c) Connect optional carabiner or loop together for pushing the retaining cable and **BRAWOLINER®** using loops, Close the loops tight with cable ties.



- d) Cut the protruding tip of the cable tie as short as possible to prevent damage, tape over the cable tie.



- e) Completed knots



4.1.7 Inverting the BRAWOLINER®

Inversion of the BRAWOLINER® with BRAWO® inversion drum

CAUTION!



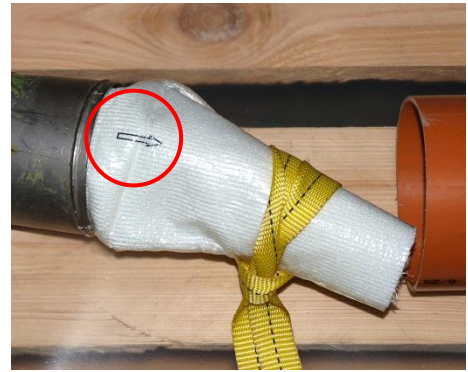
DANGER OF CRUSHING!

Wear protective gloves in the area of the handwheel.

ATTENTION!



- Spray the impregnated BRAWOLINER® again with a lubricant, such as silicone spray, while bringing it into the BRAWO® inversion drum. This increases the gliding properties of the BRAWOLINER® during the inversion. To protect the lights do not use oil or detergent!
- Direction of installation: The arrow imprinted on the liner must always point in the direction of the rehabilitation start (beginning of pipe).



ATTENTION!



- Especially during installation of the BRAWOLINER® 3D with open end, the TPU film must be provided with sufficient lubricant, for example silicone spray. This prevents a “blocking” of the calibration CIPP, e.g. at dimensional offsets.
- The retaining strap, possibly CIPPs and calibration CIPP must already be in the BRAWO® inversion drum before winding up the BRAWOLINER®!

- The installation recommendations for inversion pressures on [page 20](#) must be followed.
- Especially the BRAWOLINER 3D DN 200-300 must be supported outside of the pipe during insulation with closed end:
 - between inversion bend and beginning of the pipe
 - at the pipe ende.g. by a suitable calibration CIPP or support pipe (pay attention to dimension).

1. Wind the **BRAWOLINER®** onto the drum axle. The arrow on the surface of the wound up liner must point away from the drum axle and in the direction of the inversion nozzle.



2. Push the beginning of the **BRAWOLINER®** through the inversion nozzle and the nominal diameter related inversion pipe with the aid of a retractable cable.





3. Fold the beginning of the **BRAWOLINER[®]** over the inversion pipe by forming a cuff.



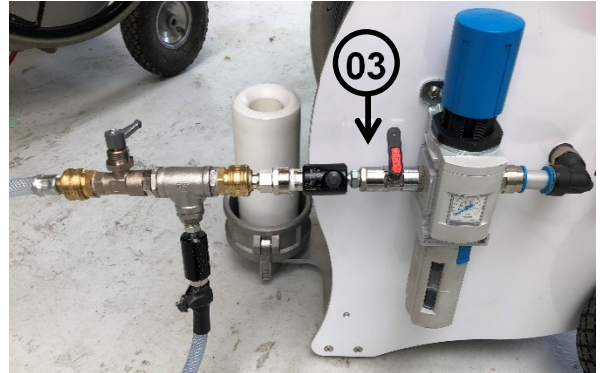
4. Protect the cuff from damage with adhesive tape and fasten with at least two CIPP clamps onto the inversion pipe.



5. Align the inversion pipe to the pipe to be rehabilitated (2nd operator), and if necessary position in the preliner.

BRAWO® SYSTEMS

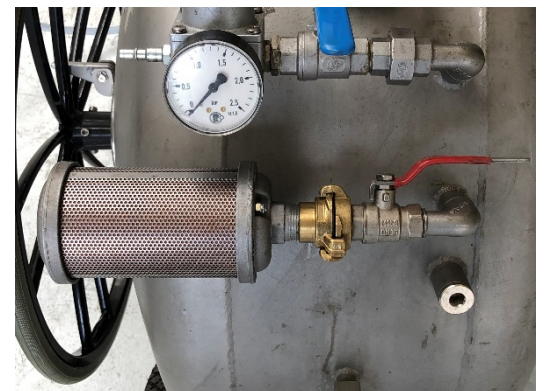
- The 2nd operator gives the signal to start. Then the 1st operator opens the compressed air supply on the pressure control valve (Pos. 03; Fig.: example of BRAWO® Magnavity). As a rule inversion is done with a pressure of 0.2 - 0.3 bar. Special conditions on site can require deviating pressures (see **ATTENTION!** on [page 29](#)).



- The inversion speed can be impacted on the pressure control valve (Pos. 03) and on the handwheel of the BRAWO® inversion drum.
- The liner is inverted up to half, when the retaining cap is just before the gate valve. When this point is reached, the airlock can be closed.



- The area behind the airlock is depressurized with the aid of the pressure drain valve on the drum. In addition, for safety reasons the inspection glass of the drum is opened. The liner remains pressurized.

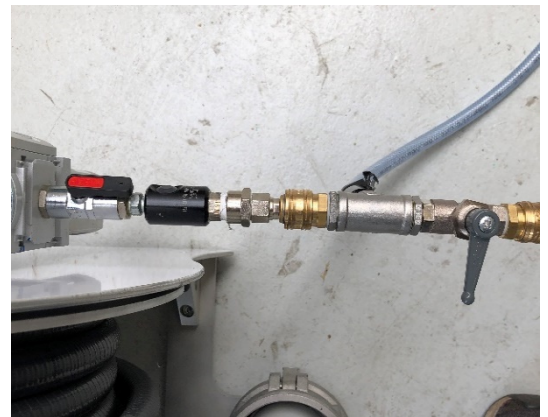


BRAWO® SYSTEMS

10. If it is ensured that there is no pressure in the rear system, the side cover can be opened and the magnet connected with the holder cup, activate the electromagnet via the BRAWO® Magnavity controls.



11. The rear system is now reconnected and the pressure equalization is controlled by the drain valve on the drum. By opening the airlock both systems are connected. The continuing inversion process is now transferred via the bypass to the LED head. If necessary the inversion can be supported by activating the retraction unit (push function).



12. The inversion is completed when the **BRAWOLINER®** has reached the end of the rehabilitation section. Lock the handwheel. The pressure in the rehabilitation section must be maintained at 0.4 – 0.5 bar until complete curing. Special conditions on site can require deviating pressures (see **ATTENTION!** on [page 29](#)).



10. Curing: see [section 4.3.0 "Light curing"](#) on [page 69](#).

11. For further working methods see the [section 4.4.0 "Ending the installation – depending on the variant"](#) starting on [page 73](#).

4.2.0 Installation with open end

In these process instructions the **BRAWOLINER[®]** process for the **house connection rehabilitation** (**BRAWOLINER[®]** system) is treated with light cured vinyl ester resin.

ATTENTION!



- The installation must only be carried out by trained specialist personnel.
- Pay special attention to the **section 2.0.0 “Safety - accident prevention”** on **page 5**.
- The installation direction is as a rule in the direction of flow (with the downward gradient).
- In case of in situ ground water, the installation pressure must be around 0.4 bar above the possible ground water pressure. The installation of a liner is possible up to a ground water level of 4 m.
- Do not set an installation pressure > 0.8 bar in any case.
- The installation recommendations for inversion and curing pressure for the individual liner types on **page 20** must be observed.
- The following described installation process is oriented to a normal case. Deviations can be caused by conditions on site and must be recognized by the specialist personnel.



- The **section 4.0.0 “Installation process – Guidelines”** is structured in steps. The sequence listed here must absolutely be complied with.
- The rehabilitation is to be documented. For this also refer to **section 7.4.0 “Curing speeds” on page 80** and **section 8.0.0 “Installation Protocol” on page 81**.

4.2.1 Preparation of the line to be rehabilitated

NOTE!



The foundation must be clean and free of all loose parts, dust, oil, grease or other substances that could have a negative effect on adhesion. It can be dry or damp. The foundation must be capable of carrying the load and have a generally required tear strength of min. 1.5 N/mm².

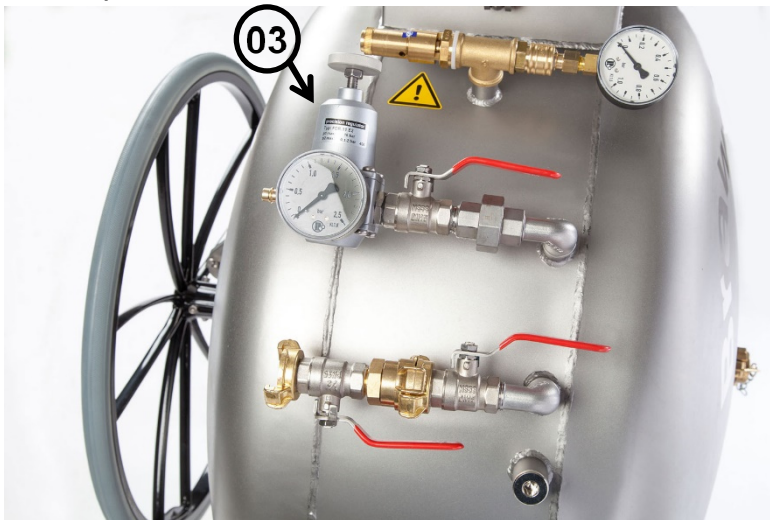
1. High-pressure cleaning of the line to be rehabilitated
2. Pictures of damage using inspection camera.
3. Remove all hindrances, for example with a milling robot. Protruding hindrances can damage the **BRAWOLINER[®]** during installation.
4. Establish the length of the rehabilitation section, record the pipe diameter and calibrate.
5. Calibrate all supply lines. An approximate determination of the positions of the supply lines in piping systems without dimensional offsets is completely adequate, since the bulges of the **BRAWOLINER[®]** in these areas can be clearly recognized with a camera. During the rehabilitation of pipe lines with dimensional offsets or with the use of a calibration CIPP, the exact positions of the supply lines must be determined, since the bulges here can be less pronounced here.

6. To prevent any leaking of resin into the ground, there is the possibility of installing a preliner before the rehabilitation, refer to the **section 4.1.3 “Inverting the preliner”** on **page 32**.
7. Make sure that during the rehabilitation that no waste water is introduced. Block storm water inlet, if necessary.

4.2.2 Establishing operational readiness

BRAWO® Inversion Drum

1. Put the BRAWO® in inversion drum in position. Make compressed air connection on the pressure control valve Pos. 03.



2. Make sure that all ball valves are closed.
3. Have the correct inversion pipe, airlocks for the light curing system, inversion CIPP and Storz CIPP coupling wrench ready.
4. Pull in the retractable cable (for pulling through the liner later).
5. Fasten the retaining cable with one end on the drum reel and wind several layers around the axle. This must have approximately double the length of the **BRAWOLINER®** to be installed.
6. Have ready the correct CIPP clamps, cable ties, adhesive tape and rechargeable screwdriver.

7. Ensure power supply.
8. Prepare BRAWO® impregnation system.
9. Move the light curing system in operational readiness.
10. Check the functionality of the installation equipment.

4.2.3 Inverting the preliner

CAUTION!



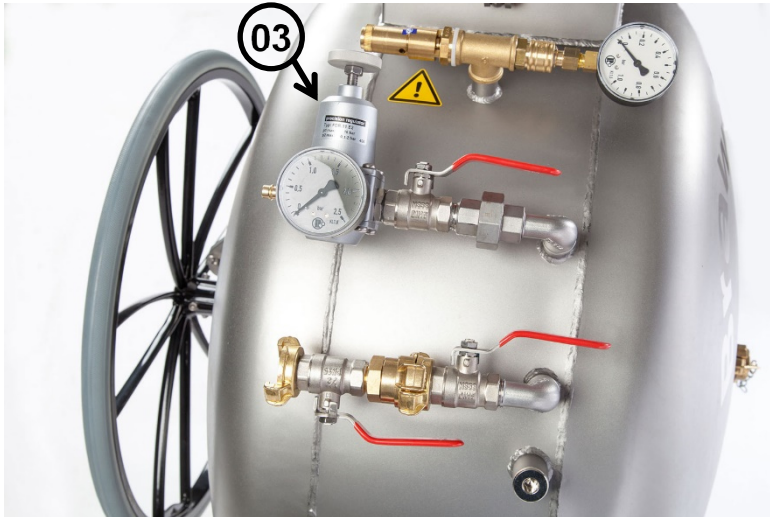
DANGER OF CRUSHING!
Wear protective gloves in the area of the handwheel.

The required length of the preliner is made up of the following factors:

Rehabilitation length + addition for fastening on the inversion pipe

1. Wind up the preliner with the open end on the drum axle. Do not connect the end of the preliner with the retraction cable!
2. Push through the beginning of the preliner with the aid of the retractable cable, inversion nozzle, inversion CIPP and the corresponding inversion pipe.
3. Invert the beginning of the preliner on the inversion pipe and fasten with at least two CIPP clamps.
4. Align the inversion pipe to the pipe to be rehabilitated (2nd operator).

5. The 2nd operator gives the signal to start. Then the 1st operator (is positioned on the BRAWO® inversion drum) opens the compressed air inlet on the pressure control valve (Pos. 03). Normally inversion is done with a pressure of approx. 0.2–0.3 bar. Special conditions on site can require deviating pressures.



6. The inversion speed can be impacted by the pressure control valve (Pos. 03).
7. The inversion of the preliner is completed when the preliner has reached the end of the rehabilitation section (system pressure escapes).
8. Close the pressure control valve (Pos. 03).
9. Open the CIPP clamps on the inversion pipe and fasten the preliner on the shaft.

4.2.4 Cut the calibration CIPP to length, close it and prepare it for the inversion.

ATTENTION!



Only necessary if the installation variant “open end” will be used.

The required length of the calibration CIPP is made up of the following factors:

- Rehabilitation length
- + Addition for fastening on the inversion pipe
- + approx. 40 cm to close the calibration CIPP
- + approx. 60 cm for safety reasons

- = Length of the calibration CIPP

NOTE!



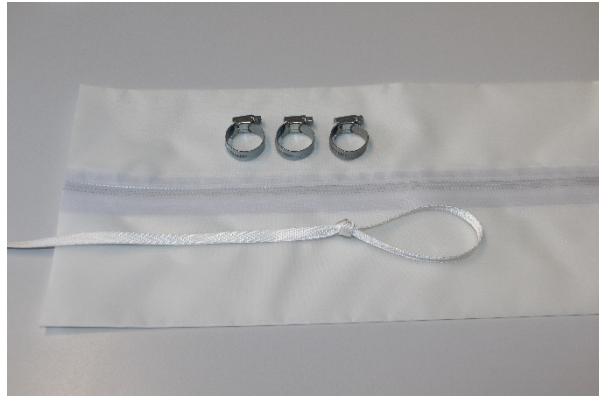
The calibration CIPP must always be somewhat longer than the BRAWOLINER[®]. Other additions could be necessary depending on the construction site. However, if the calibration CIPP protrudes unprotected too far over the end of the pipe, there is danger of rupture!

Attention!



When curing with light a translucent calibration CIPP must be used.

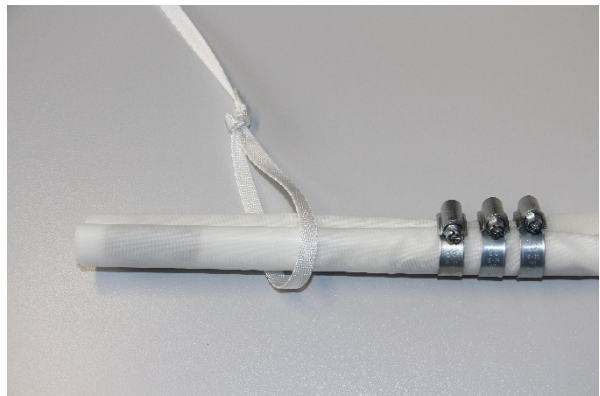
1. Cut the calibration CIPP to length.
2. Close the calibration CIPP airtight and pressure-tight:



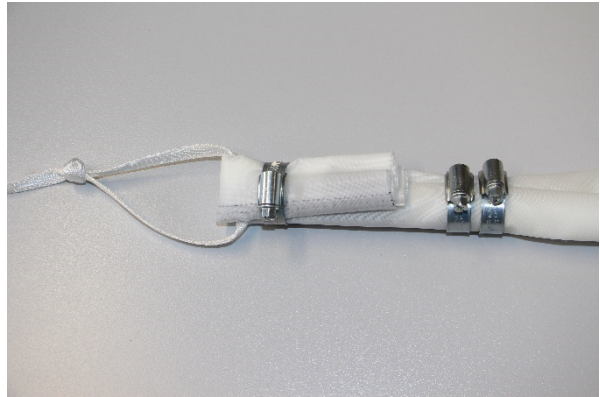
3. Fold the end of the calibration CIPP lengthwise.



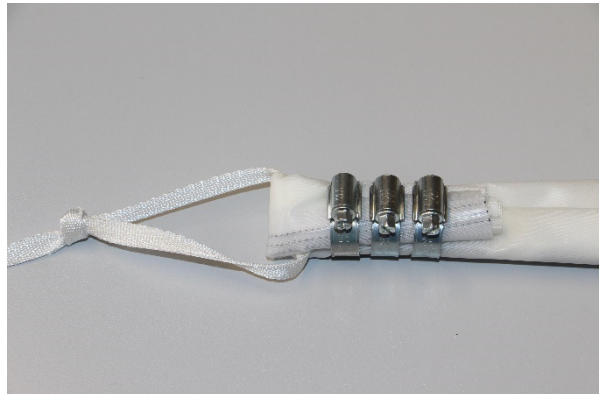
4. Catch the folded piece with at least three loose CIPP clamps. Connect the retaining strap and calibration CIPP with each other via loops. For the BRAWO® Magnavity the magnet holder cup must also be fastened in the loop.



5. Pull the CIPP clamps over the folded part of the calibration CIPP.



6. Tighten the CIPP clamps evenly and tightly.



7. To prevent damage, tape over the CIPP clamps.



Wind the closed calibration CIPP connected with the retaining strap on the drum axle using the retaining strap.

8. Fix the beginning of the calibration CIPP on the drum axle with adhesive tape. The **BRAWOLINER®** is then wound over it.

4.2.5 Cut the BRAWOLINER® to length, close and prepare for the impregnation.

Rehabilitation length

- + Addition for fastening on the inversion pipe
 - + approx. 20 cm addition for vacuum cup (is cut off after the impregnation)
-
- = Length of the BRAWOLINER®

NOTE!



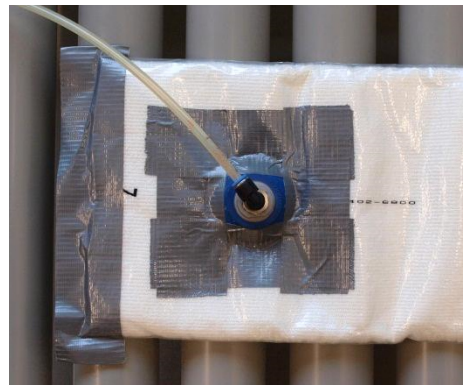
The BRAWOLINER® is a flexible liner. Too high an inversion pressure can cause the material to stretch.

1. Lay out the BRAWOLINER® with no wrinkles.
2. Cut the BRAWOLINER® to length.
3. Lay out the BRAWOLINER® on the BRAWO® impregnation system. The imprinted arrow must always point from the roller strap in the direction of the impregnating roller.
4. Fold back a cuff at the beginning of the BRAWOLINER® (will also be used later for fastening on the inversion pipe) The imprinted arrow must always point in the direction of the cuff.



BRAWO® SYSTEMS

5. Close the end of the **BRAWOLINER®** airtight with an adhesive tape.
6. Make a cut of approx. 1-2 cm in the outer film at the end of the **BRAWOLINER®**.
7. Set the suction cup of the vacuum pump on this cut, if necessary fix with adhesive tape and suck the air out of the **BRAWOLINER®** with approx. 500 mbar vacuum.



4.2.6 Impregnating the BRAWOLINER®

DANGER! *Vinyl ester resin...*



GHS 07



GHS 09



GHS 05



- *Causes severe eye damage*
- *Causes skin irritation*
- *Can cause allergic skin reaction*
- *Can irritate the respiratory system*
- *Toxic to water organisms with long-term effects*

- ⇒ **Always wear safety glasses and protective gloves.**
- ⇒ **Do not, eat, drink or smoke while working.**
- ⇒ **Do not inhale dust/smoke/gas/spray/aerosol. Ensure good ventilation during the entire work process.**
- ⇒ **Follow current safety data sheets.**

ATTENTION!



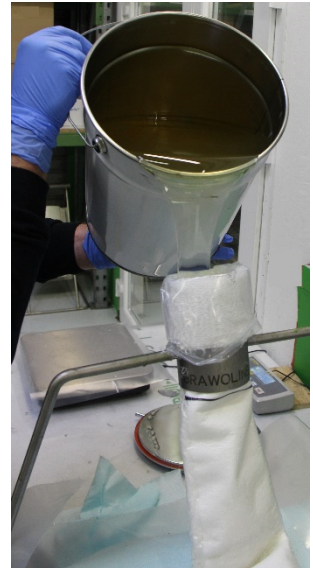
CAUSTIC EFFECT / RISK TO HEALTH!

- Safety glasses with side shields or eye protection acc. to DIN EN 166
- Chemical-resistant protective overall
- Chemical-resistant protective gloves tested acc. to EN374, e.g. made of nitrile rubber.
- Wear filter mask type A, based on the danger and risk of an exposure.
- Observe current safety datasheet.

1. Calculate the required quantity of resin. Refer to **section 7.3.0 "Resin"** on **page 79**.

BRAWO® SYSTEMS

2. Fill the resin in the **BRAWOLINER®**.
3. Fold back the cuff again on the fill end to prevent possible leakage of resin.
4. Distribute and work in the resin with the BRAWO® impregnation system. Select and set the roller distances corresponding to the **section 7.3.0 "Resin"** on **page 79**. Normally one to two rolling passes are necessary to impregnate the **BRAWOLINER®** evenly.
5. Check the length of the **BRAWOLINER®** if necessary.
6. The impregnated **BRAWOLINER®** is brought to the BRAWO® inversion drum.

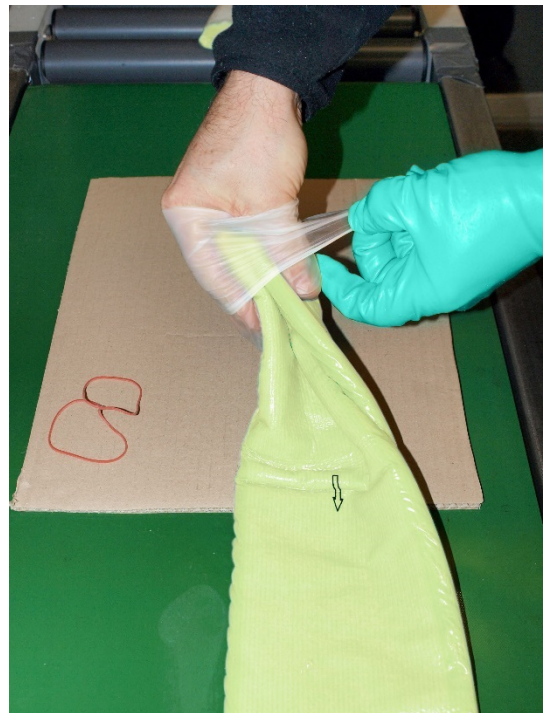


4.2.7 Close the BRAWOLINER® end

1. Cut of the end of the **BRAWOLINER®** at the marking of the linear length (rehabilitation length + addition for fastening on the inversion pipe). Pay attention that the liner is completely saturated with resin until over the marking.



2. Fold the **BRAWOLINER®** lengthwise and pull a rubber glove over it to prevent leakage of resin into the BRAWO® inversion drum.



3. Fasten the glove with a rubber ring. Do not connect the retaining strap!



4.2.8 Inverting the BRAWOLINER[®]

Inversion of the BRAWOLINER[®] with BRAWO[®] inversion drum

CAUTION!



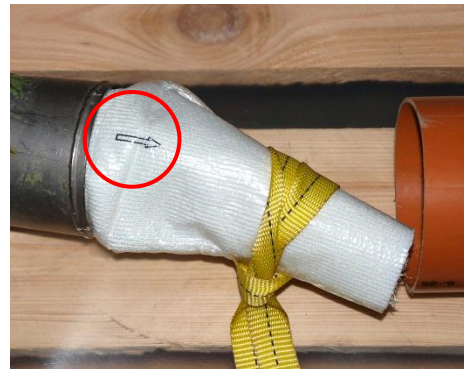
DANGER OF CRUSHING!

Wear protective gloves in the area of the handwheel.

ATTENTION!



- Spray the impregnated BRAWOLINER[®] again with a lubricant, such as silicone spray, while bringing it into the BRAWO[®] inversion drum. This increases the gliding properties of the BRAWOLINER[®] during the inversion. To protect the lights do not use oil or detergent!
- Direction of installation: The arrow imprinted on the liner must always point in the direction of the rehabilitation start (beginning of pipe).



ATTENTION!



- Especially during installation of the BRAWOLINER[®] 3D with open end, the TPU film must be provided with sufficient lubricant, for example silicone spray. This prevents a “blocking” of the calibration CIPP, e.g. at dimensional offsets.

- The retaining strap, possibly CIPPs and calibration CIPP must already be in the BRAWO® inversion drum before winding up the BRAWOLINER®!

1. Wind the **BRAWOLINER®** onto the drum axle. The arrow on the surface of the wound up liner must point away from the drum axle and in the direction of the inversion nozzle.



2. Push the beginning of the **BRAWOLINER®** through the inversion nozzle and the nominal diameter related inversion pipe with the aid of a retractable cable.





3. Fold the beginning of the **BRAWOLINER[®]** over the inversion pipe by forming a cuff.

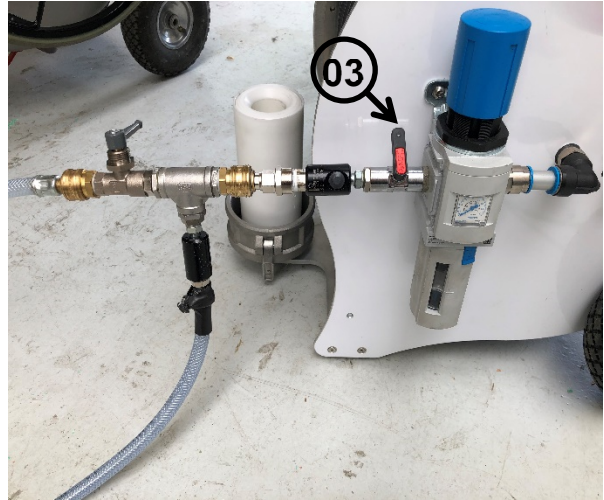


4. Protect the cuff from damage with adhesive tape and fasten with at least two CIPP clamps onto the inversion pipe.



5. Align the inversion pipe to the pipe to be rehabilitated (2nd operator), and if necessary position in the preliner.

6. The 2nd operator gives the signal to start. Then the 1st operator opens the compressed air supply on the pressure control valve (Pos. 03). As a rule inversion is done with a pressure of 0.2 - 0.3 bar. Special conditions on site can require deviating pressures (see **ATTENTION!** on **page 29**).



7. The inversion speed can be impacted on the pressure control valve (Pos. 03) and on the handwheel of the BRAWO® inversion drum.
8. The inversion is completed when the **BRAWOLINER®** has reached the end of the rehabilitation section, the rubber ring has sprung off and the **BRAWOLINER®** collapses.

4.2.9 Inverting the calibration CIPP

Inversion of the calibration CIPP with BRAWO® inversion drum

CAUTION!



DANGER OF CRUSHING!

Wear protective gloves in the area of the handwheel.

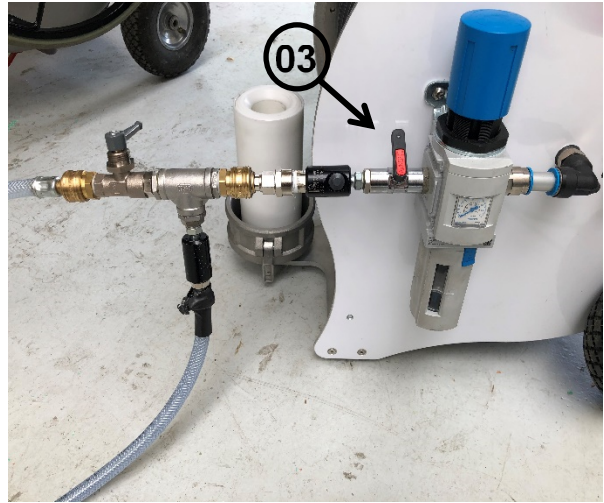
ATTENTION!



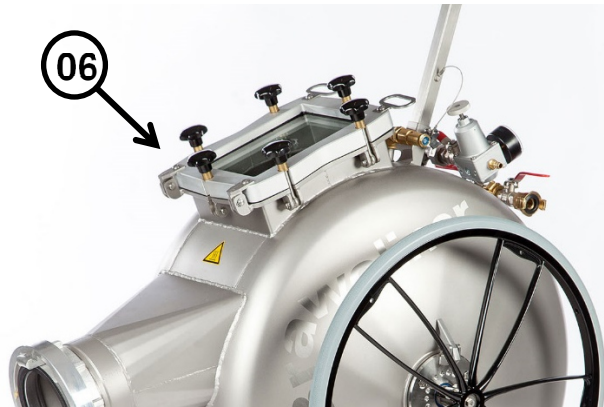
RISK OF INJURY FROM EXCESS AIR PRESSURE!

Before opening components, make sure that the system is depressurized!

1. Close the pressure control valve (Pos. 03).

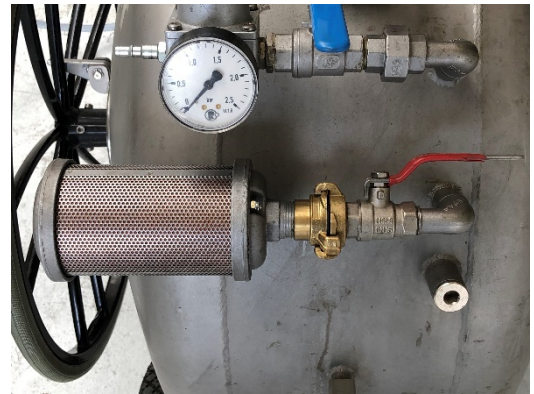


2. Open the CIPP clamp on the inversion pipe, loosen the **BRAWOLINER®** and secure against slipping.
3. Open the inspection glass (Pos. 06) and push the beginning of the calibration CIPP through the inversion nozzle and the inversion pipe with the aid of the retraction cable.



4. Fold over the beginning of the calibration CIPP on the inversion pipe, fix with adhesive tape and together with the already inverted **BRAWOLINER®** fasten with at least two cable clamps. Close the inspection glass (Pos. 06) airtight.
5. Align the inversion pipe to the pipe to be rehabilitated (2nd operator).
6. The 2nd operator gives the signal to start. Then the 1st operator opens the compressed air supply on the pressure control valve (Pos. 03). As a rule inversion is done with a pressure of 0.2 - 0.3 bar. Special conditions on site can require deviating pressures (see **ATTENTION!** on **page 29**).
7. The inversion speed can be impacted on the pressure control valve (Pos. 03) and on the handwheel of the BRAWO® inversion drum.
8. The calibration CIPP is inverted up to half, until the retaining cap is just before the gate valve. When this point is reached, the airlock can be closed.

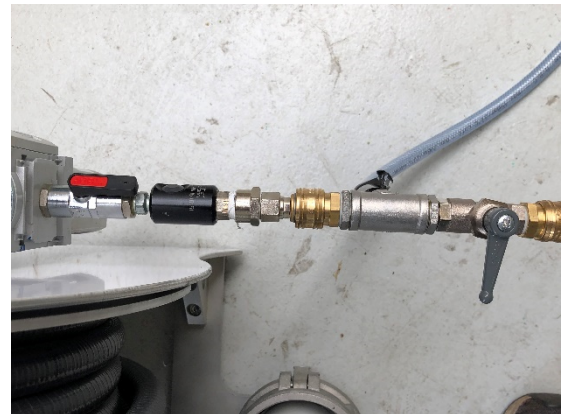
9. The rear area of the system is depressurized with the aid of the pressure drain valve on the drum. In addition, for safety reasons the inspection glass of the drum is opened.



10. If it is ensured that there is no pressure in the rear system, the side cover can be opened and the magnet connected with the holder cup, activate the electromagnet via the BRAWO® Magnavity controls.



11. The rear system is now reconnected and the pressure equalization is controlled by the drain valve on the drum. By opening the airlock both systems are connected. The continuing inversion process is now transferred via the bypass to the LED head. If necessary the inversion can be supported by activating the retraction unit (push function).



12. The inversion of the calibration CIPP is completed when the calibration CIPP has reached the end of the rehabilitation section.

ATTENTION!



If the BRAWOLINER[®] 3D is inverted, the increased pressure of min. 0.4 bar must be maintained during the curing.

13. Lock the handwheel.



14. The pressure in the rehabilitation section must be maintained until the resin is cured. Special conditions on site can require deviating pressures (see **ATTENTION!** on [page 16](#)).

15. Curing: See [section 4.3.0 "Light curing"](#) on [page 69](#).

16. For further working methods see the [section 4.4.0 "Ending the installation – depending on the variant"](#) starting on [page 73](#).

4.3.0 Light curing

The curing of the laminate with the styrene-free vinyl ester resin BRAWO® LR is done using a suitable curing technology. Gas discharge lamps or LEDs in the wave length range of 360 nm to 450 nm can be used for the curing.

For gas discharge lamps a total output of minimum 300 W (e.g. 3 x 100 W) in the nominal diameter range of DN 100 - 150 or 600 W (e.g. 3 x 200 W) in nominal diameters > DN 150 should be used.

For LEDs in the wave length range of 360 nm to 450 nm a total output of at least 100 W in the nominal diameter range of DN 100 - 150 or 200 W in nominal diameters > DN 150 should be used.

DANGER!



- **UV RADIATION IRRITATES AND DAMAGES THE EYES (RISK OF BLINDNESS)**
Protect the eyes from UV radiation using UV safety glasses. Do not look into the light sources
- **RISK OF SKIN BURNS!**
Protect with suitable clothing. Do not expose unprotected skin to UV radiation.

CAUTION!



- **RISK OF BURNS!**
Risk of burns on the light sources of the light curing system and on freely accessible liner and free-lying old pipe.

ATTENTION!



The required preconditions for use of the light curing system must be observed. The separate operating and maintenance instructions of the light curing system must be followed.

NOTE!



The light curing system contains control and retraction units, reel and pushrod as well as one or more light sources, e.g. medium pressure gas discharge lamps or LEDs.

General preparations:

1. Preparing the inversion drum:

The inversion drum is provided with the airlock for the light source and a suitable nozzle and positioned at the inlet of the holder.

2. Preparation of the control unit:

The control unit is set at a suitable location near the inlet of the holder and connected to 230V power.

3. Preparation of the pushrod and light sources:

The light source is then placed in the airlock on the inversion drum and these are connected with Venturi nozzles with the lock. In this manner the pressure must not be released after the inversion.

4. Preparation of the retraction unit:

The retraction unit is positioned behind the airlock with the light source and if necessary the control cable is plugged into the connection provided for it on the control unit.

Curing of the CIPP liner using light:

1. Commissioning of the light curing system:
Switch on the light curing system: During this the operating manual of the light curing system must be followed!
2. Invert the **BRAWOLINER®**: For this refer to the **section 4.1.7 “Inverting the BRAWOLINER®”** starting on **page 41** or for the open end of the inversion of the calibration CIPP. For this refer to the **section 4.2.9 “Inverting CIPP”** starting on **page 65**.
3. Introducing the light source: Introduce the pushrod through the Venturi nozzle using the magnets during the inversion process into the pressurized liner (BRAWO® Magnavity). For the BRAWO® Magnavity this process can be done with the aid of the two installed cameras.
For other light curing systems push the light source after the inversion to the end of the pressurized liner if necessary.
4. Preparation of the retraction unit: The pushrod is placed into the retraction unit and fixed.
5. Setting the retraction speed: The curing time is dependent on the nominal dimension and wall thickness of the CIPP liner and the light source used. The suitable retraction speed (see the **section 7.3.0 “Curing Speeds”** on **page 79**) is set on the control unit. The set value is shown on the display on the control unit.

NOTE!



Pay attention to the retraction speeds in different pipe dimensions.

Refer to the **section 7.4.0 “Curing speeds” on **page 79** and the technical datasheet of the resin **BRAWO® LR**.**

6. Turn on the light source. When using BRAWO® Magnavity also switch off the magnets.
7. Light curing: Start the retraction unit. The retraction speed is then shown on the display of the retraction unit. In addition the retraction of the light source can be

monitored with the integrated camera via the display in the control unit. During the curing there is a reaction heat in the laminate. The process temperatures can be followed on the display. Pipe sections, which the light source has passed, are already cured.

8. After the light source has been pulled completely through the holder, turn off the light source and stop the retraction.

NOTE!



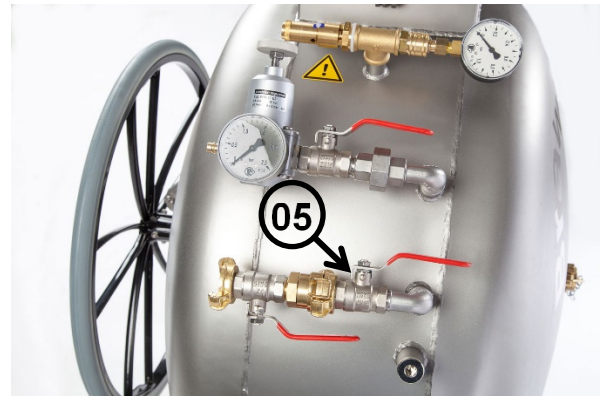
Maintain the compressed air supply after switching the BRAWO® Magnavity LED head off until the LED head temperature has cooled to 30 °C.

9. Switch off the control unit.
10. For further working methods see the **section 4.4.0 “Ending the installation – depending on the variant”** starting on **page 73**.

4.4.0 Ending the installation – depending on the variant

Installation with closed end

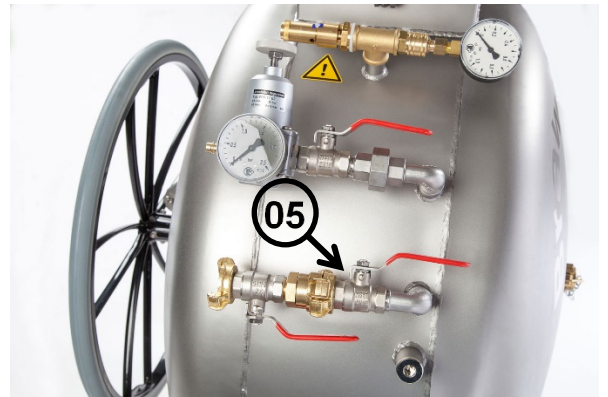
1. After the complete curing, release the system pressure (open ball valve Pos. 05).
2. Open the CIPP clamps on the inversion pipe.
3. Cut the **BRAWOLINER®** flush with the old pipe. Equalize unevenness in the bottom area if necessary (e.g. with cement mortar).
4. If necessary open closed supply lines with a suitable tool.



– The installation variant selected is completed –

Installation with open end

1. After the completed curing of pull out the calibration CIPP under low pressure (approx. 0.05 bar) with the aid of the retaining strap from the **BRAWOLINER®** by turning back.
 2. After pulling back completely, release the system pressure (open ball valve Pos. 05).
 3. Open the CIPP clamps on the inversion pipe.
 4. Cut the **BRAWOLINER®** flush with the old pipe. Equalize unevenness in the bottom area if necessary (e.g. with cement mortar).
 5. If necessary open closed supply lines with a suitable tool.
- The installation variant selected is completed –



5.0.0 Service and maintenance

ATTENTION!



- Information on the maintenance and inspection schedules to comply with must be taken from the respective operating and service instructions of the individual machines and devices.
- Always replace defective parts with original accessories from BRAWO SYSTEMS GmbH. Only in this way is perfect operation of the machine/system ensured.
- Calibration, repair and maintenance work may only be done by authorized specialists.
- Follow relevant occupational safety and accident prevention regulations.
- Ensure safe and environmentally friendly disposal of operating and auxiliary materials and exchange parts.

6.0.0 Troubleshooting

For this refer to the respective operating manuals of the individual machines and devices.

7.0.0 Things to know about reaction resins

The styrene-free vinyl ester resin used is a so-called reaction resin.

7.1.0 What are reaction resins?

Reaction resins are processed in the liquid state on the construction site. They harden through chemical reaction in a relative short time. Reaction resins can of the corresponding composition can achieve high mechanical strengths, as well as resiliencies against chemicals and weather influences.

7.2.0 Processing instructions

ATTENTION!



Observe the technical datasheets and the safety datasheets of the corresponding resins. They can be found, for example, in the download area at www.brawosystems.com.

When handling these resins the safety rules must be observed. Refer to **[section 2.4.0](#)** ***“Sources of danger – accident prevention”*** on **[page 8](#)**.

Storage:

Storage must be frost-free (>5°C) and should be kept as cool as possible. The storage must be done protected from light and air, i.e. with closed covering.

Processing temperature:

The resin temperature has no influence on the reactivity of the resin, therefore processing is possible at ambient temperature. To ensure an optimum processibility, however, we recommend to temper the resin to +15 °C before processing.

ATTENTION!



During preparation and processing do not expose the resin to any direct sunlight or UV light, since this leads to curing of the resin!

7.3.0 Resin consumption of BRAWOLINER®

BRAWOLINER®

DN	To achieve wall thickness of min. 3 mm	
	Roller distance	BRAWO® LR in kg / m
100	8.5mm	1.1
125		1.4
150		1.7
200		2.3

BRAWOLINER® 3D

DN	To achieve wall thickness of min. 3 mm.	
	Roller distance	BRAWO® LR in kg / m
70 -100	7.0mm	0.9
100 – 150	12.0mm	1.5
150 – 200		2.3
200 – 300	14.0mm	4.1

BRAWOLINER® XT

DN	Roller distance	BRAWO® LR in kg / m
100	11.0mm	1.7
125		2.0
150		2.3
200		3.1

All data is understood to be approximate and based on experimentally determine values. Deviations dependent on ambient conditions possible.

7.4.0 Curing speeds

7.4.1 BRAWO® Magnavity curing speeds

Liner	DN	Retraction speed in m/min	
		LED head Nano_96	LED head Mega_192
BRAWOLINER® 3D DN 70-100	70	0.6	-
BRAWOLINER® 3D DN 70-100	100	0.6	-
BRAWOLINER® 3D DN 100-150	100	0.6	-
BRAWOLINER® 3D DN 100-150	125	0.55	0.7
BRAWOLINER® 3D DN 100-150	150	0.5	0.7
BRAWOLINER® 3D DN 150-225	150	0.45	0.7
BRAWOLINER® 3D DN 150-225	200	0.4	0.7
BRAWOLINER® 3D DN 150-225	225	0.3	0.7
BRAWOLINER® XT DN 200	200	0.3	0.7
BRAWOLINER® XT DN 200	225	0.25	0.6
BRAWOLINER® XT DN 200	250	0.2	0.5
BRAWOLINER® DN 200-300	200	-	0.6
BRAWOLINER® DN 200-300	225	-	0.5
BRAWOLINER® DN 200-300	250	-	0.4
BRAWOLINER® DN 200-300	300	-	0.3

The operating manual of the BRAWO® Magnavity system must be observed.

All data is understood to be approximate and based on experimentally determined values.

7.4.2 Curing speeds BRAWO® LumCure/Prokasro Ikarus (3x200W) /UV-Relining UV 600 RS (1x600W)

Liner	DN	Retraction speed in m/min	
		Closed end	open end
BRAWOLINER® / BRAWOLINER® 3D	100	0.6	0.4
BRAWOLINER® / BRAWOLINER® 3D	125	0.5	0.3
BRAWOLINER® / BRAWOLINER® 3D	150	0.4	0.2
BRAWOLINER® / BRAWOLINER® 3D	200	0.3	0.2
BRAWOLINER® XT	100	0.5	0.3
BRAWOLINER® XT	125	0.4	0.2
BRAWOLINER® XT	150	0.3	0.2
BRAWOLINER® XT	200	0.2	0.1

The operating manual of the curing system used must be observed. Status of the recommended curing speeds 2019. Further developments not considered.

All data is understood to be approximate and based on experimentally determine values.

If a light source fails, reduce the retraction speed proportionally (ex.: for failure of a light source in a 3-track, the series chain, the swipe speed reduces by 1/3).

8.0.0 Installation protocol

The installation protocol presented in the appendix is a recommendation from us and includes all the important details in order to also understand the rehabilitation at a later time.

Installation protocol BRAWOLINER® light cure			Page:			Weather			Deployment manager:		
			Date:			Temperature:			Personnel:		
						Precipitation:			Col. vehicle:		
Place of deployment:				Customer:				Site number:			
TV preliminary inspection (* circle applicable)	YES *	NO *	HP cleaning	YES	NO	Daytime cordoning off	YES	NO			
TV post-inspection	YES	NO	Calibration	YES	NO	Milling work	YES	NO			
DN:	Lengt:		Material:			From Shaft:		To Shaft:			
Shaft depth in [m]:			Location:			Diameter in [m] :					
Gradient (height difference) in [m]:			Type of damage:			Number / location of inlets:					
Bends:											
Material	Material specification by		Cus.	<input type="checkbox"/>	Cont./site manager	<input type="checkbox"/>	Cont./polisher	<input type="checkbox"/>	Comments:		
Liner	Brawoliner	<input type="checkbox"/>	Brawoliner 3D	<input type="checkbox"/>				Nominal diameter DN:	Resin		Batch No.:
	Brawoliner XT	<input type="checkbox"/>	Connection sl.	<input type="checkbox"/>				Batch number case:	BRAWO LR		
Installation											
Preliner used		YES	NO	<i>Comments:</i>					Sketch		
End	Open	Sleeve	Closed								
Calibration hose		YES	NO								
Waste water-free?		YES	NO								
Resin storage temperature (TARGET: 5°C - 25°C):		°C									
Resin temp. before inst. (TARGET: 15°C - 20°C)		°C									
Resin quantity in [kg/m]:		Total [kg]:									
Mixed / homogenised		YES	NO	Roller spacing:		mm					
Impregnation		On site <input type="checkbox"/>		Pre impregnated		<input type="checkbox"/>					
Inversion pressure (TARGET: 0.2 - 0.3 bar):		bar									
Curing											
Test UV/LED lamp		YES	NO								
Curing condition		Used UV-unit		BRAWO® Magnavity <input type="checkbox"/>		UV-Relining <input type="checkbox"/>		BRAWO® LumCure <input type="checkbox"/>			
		Number power of UV-Lamps		Nano 1 x 250W <input type="checkbox"/>		Mega 1 x 500W <input type="checkbox"/>		1 x 600W <input type="checkbox"/>		3 x 200W <input type="checkbox"/>	
Pullback speed		Target speed: m/min		Actual speed: m/min							
Curing pressure (TARGET 0.3 - 0.4 bar):		bar		Pressure maintainance after end (TARGET 10 min)				min			