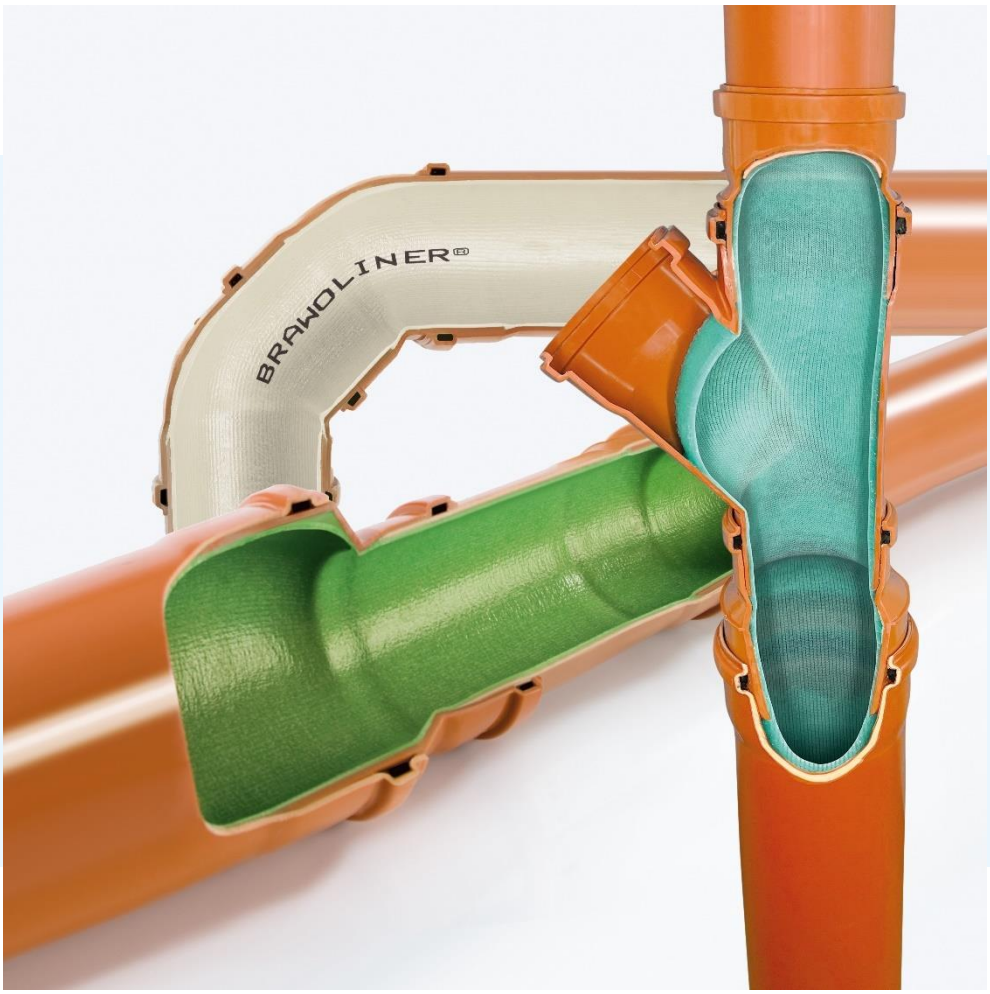
BRAWO® SYSTEMS

Process Instructions

BRAWOLINER® rehabilitation process

Light curing



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* The BRAWO® UVPox light-curing resin system refers in the following process instructions to the two systems, BRAWO® UVPox50 and BRAWO® UVPox51. The listed residual hazards, personal protective equipment, first aid measures, safety measures and the described installation process apply equally to both resin types.

1.0.0 Introduction

These process instructions, and the operating and maintenance manuals for the machines and devices used, must be available to the operators/maintenance personnel at all times. They contain important information about performing the inversion process **safely** and **properly**.

The goals of these process instructions are:

- Learning about the inversion process
- Correctly using the inversion equipment
- Installing the BRAWOLINER® properly.

Compliance is a guarantee for:

- The safety of the operating personnel
- The avoidance of hazardous states (work accidents)
- The correct operation of the inversion equipment

BRAWO® SYSTEMS GmbH is not liable for any damage and breakdowns arising from non-compliance with these process instructions.

2.0.0 Safety - Accident prevention

2.1.0 Warning notices and special information

The following nomenclature is used for safety instructions and information in these process instructions.

DANGER!

Denotes an immediate threat of danger. Failure to observe this information can lead to death or extremely serious injuries.

WARNING!

Denotes a possibly dangerous situation. Failure to observe this information could lead to severe injuries.

TAKE CARE!

Denotes a possibly dangerous situation. Failure to observe this information could lead to light injuries.

TAKE CARE!

Special information for rules and prohibitions to prevent damage.

NOTE!

Special information regarding economic operation and important additional information.

2.2.0 Proper use

- The BRAWO® inversion drum/drum 4.0 is solely designed for inversing the BRAWOLINER® with a diameter (unexpanded) of DN 50 (2 inch) to DN 300 (12 inch). Any other use over and above this will be deemed as improper use. The manufacturer/supplier is not liable for any damage resulting therefrom. The user is fully responsible for the risk.

- The intended use includes compliance with the operating instructions of the devices used, compliance with the inspection and maintenance conditions as well as compliance with the safety instructions listed in this process instructions.

- The inversion process may only be applied by appropriately trained and authorised persons. The equipment may only be serviced and repaired by qualified persons.

- Defective parts are always replaced by original accessories from the company **BRAWO® SYSTEMS GmbH**. Only this ensures the correct operation of the machine/system.

ATTENTION!

Incorrect operation or misuse will result in danger:

- **For life and limb**
- **Property**
- **The efficient work of the machine**

2.3.0 Improper use

Use of lubricants with highly flammable propellants

DANGER!

During the entire inversion process, neither aerosols (spray cans) nor pressurised gas cartridges with flammable propellants may be used in order to avoid the risk of fire and explosion.

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 current state-of-the-art and comply with accepted safety standards. Compliance with applicable health and safety at work, accident prevention and safety regulations are assumed.

Nevertheless, there are the following residual risks involved when working with the:

- **BRAWO® inversion drum / Drum 4.0**

CAUTION!

- **DANGER OF CRUSHING!**
  Use suitable protective gloves in the area of the handwheel.
  Release pressure in emergency situations: open the "Release pressure" ball valve Pos. 05 - the system pressure is vented.
- **When moving the inversion drum, there is a risk of crushing, especially the feet, on the air-filled tyres:**
  - **When moving it, ensure that there are no persons and/or objects in the travel path.**

- **Stability**
  Insufficient stability of the inversion drum can lead to personal injury:
  - **Ensure it is standing securely and will not tip over**
  - **Only use the inversion drum on a flat surface.**

WARNING!

- **Hose and pipe routing**
  Improperly routed hoses and pipes of the adapted
  peripherals (e.g. pressure generator) can lead to tripping hazards.
  Furthermore, hoses and pipes can get damaged:
  - **If possible, do not lay at floor level**
  - **Do not lay over sharp edges/corners**
  - **Bear bending radii in mind**

- **Light-curing resin systems**

DANGER!

GHS 07

GHS 09

GHS 05

- *Causes serious eye damage*
- *Causes skin irritation*
- *Can cause an allergic skin reaction*
- *Can irritate the respiratory tract*
- *Toxic to aquatic life with long lasting effects*

⇨ **Always wear safety goggles and protective gloves.**
⇨ **Do not eat, drink or smoke during work.**
⇨ **Do not inhale dust/smoke/fumes/mist/vapour/aerosols. Ensure good ventilation throughout the entire work process.**
⇨ **Comply with current safety data sheets.**

- **Light-curing system**

DANGER!

- **UV RADIATION: serious eye damage due to UV radiation**
  Protect the eyes from UV radiation by wearing UV eye protection.
  Do not look directly at the light sources!
- **DANGER OF SKIN BURNS!**
  Protect skin with suitable clothing. Do not expose unprotected skin to UV radiation.

2.4.2 Personal protective equipment

When using the:

- **BRAWO® inversion drum / Drum 4.0**

ATTENTION!

DANGER OF CRUSHING!
Use protective gloves.

CAUTION!

DANGER OF CRUSHING!
Use foot protection.

- **Light-curing resin systems**

ATTENTION!

CAUSTIC EFFECT / HEALTH HAZARD!

- **Safety goggles with side visors or eye protection according to DIN EN 166**
- **Chemical-resistant protective suit**
- **Use chemical-resistant protective gloves tested according to EN 374, e.g. made of nitrile rubber.**
- **BRAWO UVPox*:**
  - **Respiratory protection in case of high concentrations with full mask and filter**

- Respiratory protection in case of aerosol and fog formation
- Self-contained breathing apparatus

- **BRAWO LR: wear type A filter mask, based on the danger and risk of exposure**
- **Comply with the current safety data sheet.**

- **Piston compressor**

ATTENTION!

HIGH LEVEL OF SOUND!
Severe hearing damage possible. Wear ear protection.

- **Light-curing system**

ATTENTION!

UV RADIATION!

- **Serious eye damage possible. Wear UV eye protection. This must comply with welding protection level 5 and be certified according 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 (light-curing resin systems)

- **General information:**
  Light-curing resin systems can cause skin irritation and skin allergies. Skin contact must therefore be avoided at all costs.
  Remove clothing contaminated with product immediately. Symptoms of poisoning can occur after many hours; therefore medical monitoring should continue for at least 48 hours after an accident.
- **After inhalation:**
  Call a doctor immediately. Ensure a plentiful supply of fresh air. If unconscious, place and transport person in a stable side position. Keep airways open and facilitate breathing.
- **After skin contact:**
  Call a doctor immediately. Wash off immediately with water and soap, rinse thoroughly. Take off dirty clothes and shoes.
  Do not use diluting agents or solvents to clean the skin.

- **After eye contact:**
  Call a doctor immediately. Rinse eyes with open eyelid under running water for a minimum of 10 minutes or use eye wash solution. Remove contact lenses, if worn.

- **After swallowing:**
  Call a doctor immediately. Rinse mouth with water. Drink water in small quantities and provide a supply of fresh air. Do not induce vomiting!

For more information, see safety data sheets for the BRAWO® resins.

In urgent cases, please contact the Poison Information Centre at Mainz University Hospital:

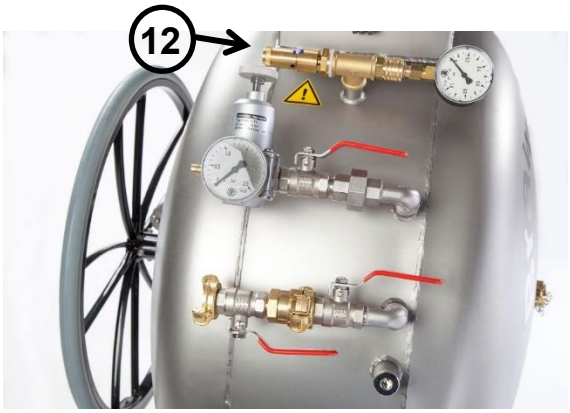
Emergency poison line: (+49) 6131 19240
Emergency telephone number (USA):
+1 872 5888271 (MCR)

2.4.4 Safety equipment

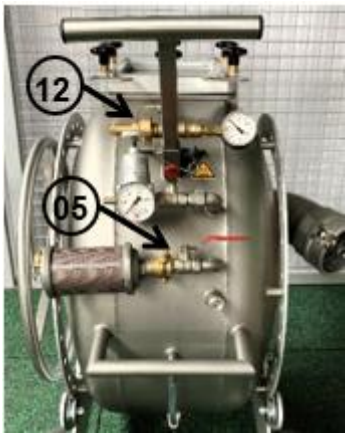
ATTENTION!

- **Operation without intact safety equipment is not permitted.**
- **Never modify, disable or remove safety equipment.**
- **It is not permitted to operate the BRAWO® inversion drum / Drum 4.0 if technical faults are present.**
- **It is not permitted to operate the light curing system if technical faults are present.**
- **Vent pressure and disconnect all auxiliary devices from the BRAWO® inversion drum / Drum 4.0 before any maintenance, repair or service work.**

A safety valve (pos. 12) is fitted to the BRAWO® inversion drum / Drum 4.0 as a safety device. This opens at 0.9 bar. Release pressure in emergency situations: open the "Release pressure" ball valve Pos. 05 - the system pressure is vented.

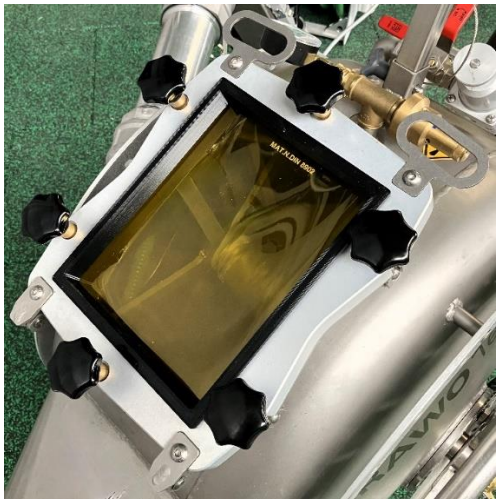


BRAWO® inversion drum



BRAWO® Drum 4.0

Before each start-up, the inspection glass seal and the UV protective film applied to the inspection glass must be checked for damage.



2.5.0 Operators' workplace and qualifications

The operator workplaces are defined in the respective operating instructions for the different machines and devices.

The operator is responsible for employing operating personnel who have been made familiar by **BRAWO® SYSTEMS GmbH** with the BRAWOLINER®, the materials to be used and the corresponding installation equipment. This instruction is confirmed by a certificate issued personally to each participant. Only these specially trained personnel may be used for the inversion process and for curing with the light curing system.

2.6.0 Noise emission

The A-rated equivalent continuous sound pressure levels of the BRAWO® Inversion drum / Drum 4.0, the BRAWO® impregnation unit, the light curing system and the vacuum pump are below 70 dB(A).

Values of over 85 dB(A) can be reached if a piston compressor is used. Set up the piston compressor outdoors. If the piston compressor has to be set up near the operating personnel due to the construction site, the operators must wear hearing protection.

When gaseous media flow out of openings, levels of over 85 dB(A) can also be reached here. Operating personnel in the immediate vicinity must wear hearing protection.

ATTENTION!

HIGH LEVEL OF SOUND!
Severe hearing damage possible. Use hearing protection.

3.0.0 Installation process - Process description

This chapter provides general information about the BRAWOLINER® rehabilitation process and is intended to provide the user with the necessary background knowledge.

3.1.0 Application area

The BRAWOLINER® light curing system covers the trenchless rehabilitation of wastewater pipes. Ducts and pipes in the dimensions of DN 50 to DN 300, with bends and changes in dimension, can be rehabilitated.

3.2.0 Brief description of the BRAWOLINER® inversion process

The installation process is approved by the Deutsche Institut für Bautechnik (DIBt).

DIBt approval No.: **Z-42.3-566 (DN 100 - DN 200)**
(Rehabilitation of underground damaged wastewater pipes with LED or UV light curing)

The damaged pipes must be appropriately prepared (cleaned, etc.) before inversing takes place. The BRAWOLINER® is soaked on site with a light-curing resin system. The resin is distributed uniformly over the entire hose length using the BRAWO® impregnation unit. Alternatively, the factory pre-impregnated BRAWOLINER® can also be prepared for inversion.

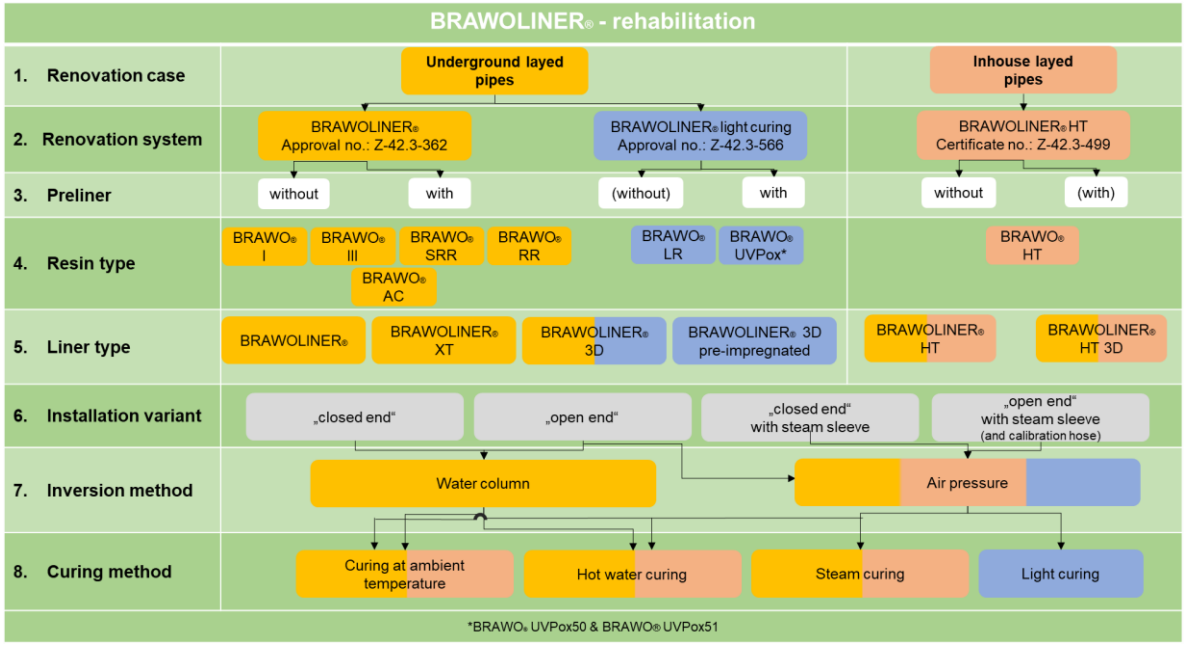
- **Installation with BRAWO® inversion drum / Drum 4.0 (compressed air)**
  The pretreated BRAWOLINER® is introduced into the BRAWO® inversion drum / Drum 4.0 and inversed into the damaged pipe by means of compressed air.

The BRAWOLINER® thereby lines the existing pipe wall.

By using the light curing system, the light-curing resin system is cured by means of light.

The rehabilitated section should be checked with a camera after curing is complete.

3.3.0 Sequence of operations



The above decision matrix provides an overview of all possible BRAWOLINER® rehabilitation methods.

The following sub-chapters look at more detail at the contents of the individual steps and help in the selection of the most suitable variant in individual cases.

For rehabilitation with the epoxy resin systems, BRAWO® RR, BRAWO® SRR, BRAWO® I, BRAWO® III, BRAWO® AC or BRAWO® HT, observe the relevant process instructions.

3.3.1 Renovation case

If renovation is possible with a hose liner, the following information is required for renovation planning. This should be determined, e.g. with a camera run after the pipe has been cleaned.

- Location of pipes (underground / in building)
- Old pipe material
- Maximum temperature loading of the pipe
- Increased chemical loading of the pipe? (industry)
- Damage image (large wall disruptions present / eventually static function of liner required?)
- Pipe length
- Nominal diameter
- Changes in nominal diameter
- Pipe routing / bends
- Number / position of the inlets
- Access options (one side / both sides?)
- Height difference between start and end of renovation section.

3.3.2 Renovation system

BRAWOLINER® system

The BRAWOLINER® system enables damaged wastewater pipes to be rehabilitated.

3.3.3 Preliner

NOTE!

- **In zones saturated with groundwater (groundwater infiltration), a preliner must be introduced in advance of the rehabilitation process.**

The preliner is a polyethylene (PE) tubular film in the diameter of the old pipe to be rehabilitated. The preliner is inversed with an open end and allowed to collapse. The beginning of the preliner is fixed to the old pipe, the BRAWOLINER® is then inversed into the preliner.

For more information on the installation process, see ***Chapter 4.3.0 "Preliner inversion"*** on ***Page 36***.

3.3.4 Resin types

During rehabilitation in the curing process with the BRAWOLINER® light curing system, the light-curable resin system BRAWO® LR or BRAWO® UVPox* can be used.

The processing instructions, required resin quantities and roller spacings can be found in the ***Chapter 6.0.0 "Important information about reaction resins"*** starting on ***Page 83***. For more detailed information on the resin, see data sheets.

3.3.5 Liner types

Depending on the renovation case, the renovation system must meet different requirements. These can be met with the following liner types.

		Liner type and application area										
BRAWOLINER® Liner type	Liner name	Sealing Function	Special static function	Ø 50	Ø 70/80	Ø 100	Ø 120/125	Ø 150	Ø 175	Ø 200/225	Ø 250	Ø 300
BRAWOLINER®	DN 50	X		Pico	Pico Nano							
	DN 70	X			Pico Nano							
	DN 100	X				Pico Nano						
	DN 125	X					Nano Mega	Nano Mega				
	DN 150	X						Nano Mega	Nano Mega			
	DN 200	X								Nano Mega		
XT	DN 150	X	X					Nano Mega	Nano Mega			
	DN 200	X	X							Nano Mega		
3D	DN 70-100	X			Pico Nano	Pico Nano						
	DN 100-150	X				Nano	Nano Mega	Nano Mega				
	DN 150-225	X						Nano Mega	Nano Mega	Nano Mega		
	DN 200-300	X								Mega	Mega	Mega

For light curing, the use of the BRAWOLINER® 3D DN 300-400 is not recommended. The following installation and curing pressures are recommended for the different liner types:

Liner type	Inversion pressure (bar)	Curing pressure (bar)	Curing pressure with calibration hose (bar)
BRAWOLINER® / 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 recommendations; the geometry and course of the rehabilitation section may require other pressures. Please also refer to the notes on** ***Page 33*****.**
- **When curing in the largest dimension, especially with the BRAWOLINER® 3D, care must be taken to ensure that the liner is in contact with the pipe wall.**
- **When inversing the BRAWOLINER® with small dimensions, especially in DN 50 and DN 70, higher inversion pressures are usually required to fold the liner into the pipe and to ensure it is in contact with the outer radius of bends.**
  Example BRAWOLINER® DN 50:
  Inversion pressure approx. 0.5 bar.

3.3.6 Installation variants

There are 2 variants for completing **the ends** of the BRAWOLINER®, dependent on the accessibility of the liner end.

3.3.6.1 Installation variant "Closed end"

For applications where:

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

This is the most common inversion method. No additional work is necessary to maintain the contact pressure in the pipe. The end of the BRAWOLINER® is opened after curing the resin by means of a suitable tool.

Setup type:

- ⇨ "Closed end" BRAWOLINER®
- ⇨ Calibration hose not required
- ⇨ Fasten retaining strap (and, if necessary, retaining cup or pull-in loop, e.g. for BRAWO® Magnavity/SX/BRAWO® Pico/SX) on the BRAWOLINER® end

For detailed instructions on how to make the knots, see ***Chapter 4.6.1 "Sealing BRAWOLINER® end "*** starting from ***Page 45*** and ***Chapter 4.7.1*** **"Closed end"**: starting from ***Page 54***.

3.3.6.2 Installation variant "Open end"

For applications where:

- BRAWOLINER® end **not** accessible

This variant is used when there is ***no*** possibility of opening the BRAWOLINER® after rehabilitation. This variant is more complex to carry out, as after inversion of the BRAWOLINER®, a calibration hose must also be inversed in order to maintain the contact pressure in the pipe.

Setup type:

- ⇨ "Open end" BRAWOLINER®
- ⇨ "Closed end" calibration hose
- ⇨ Fasten retaining strap (and, if necessary, retaining cups, e.g. for BRAWO® Magnavity/SX) on the calibration hose end

NOTE!

- **The "open end" installation option is not recommended for diameters DN 50 and DN 70.**

3.3.6.3 Calibration hose

The calibration hose is a translucent, coated textile hose, which, after inversing the BRAWOLINER®, can be inversed in this. It helps to set up the liner during installation with an open end.

Due to the resulting reaction temperature, it is important to use a temperature-resistant calibration hose.

For more information on the installation process, see ***Chapter 4.9.0 "Inverting the calibration hose"*** starting from ***Page 72***. For more detailed information on the calibration hose types, see data sheets.

3.3.7 Necessary installation equipment

Necessary devices:

1. Compressor
2. Power generator, alternatively mains supply 230V
3. Cordless screwdriver
4. Inspection camera

Always required:

1. BRAWOLINER® or pre-impregnated BRAWOLINER®
2. Light-curing resin system (e.g. BRAWO® LR, BRAWO® UVPox*)**
3. Vacuum pump**
4. Fabric adhesive tape
5. BRAWO® impregnation unit (electric or manual)**
6. BRAWO® inversion drum (compressed air) with airlock for light source or BRAWO® Drum 4.0 (no airlock required)
7. Light curing system e.g.: BRAWO® Magnavity SX or BRAWO® Pico/SX consisting of control unit, retraction unit and reel with hose set and Nano_96 LED head, Mega_192 LED head or BRAWO® Pico/SX LED head

**not when using the pre-impregnated BRAWOLINER®

Optionally required:

1. Preliner
2. Calibration hose
3. Climatic controlled cabinet for tempering the resin
4. Connection cuffs
5. BRAWO® VortexCutter
6. BRAWO® rehabilitation trailers or small vans to accommodate the complete accessories

Equipment and consumables required for rehabilitation can be purchased as individual components, up to the complete package via the company **BRAWO® SYSTEMS GmbH**.

For more information, see: www.brawosystems.com

3.3.8 Curing method: curing with light

The resin is cured by a chemical reaction that is started by light. For more information, see ***Chapter 6.0.0 "Important information about reaction resins"*** on ***Page 83***.

A light-curing system is used for curing with light. The light source is also inversed or advanced via the airlock on the inversion connection to the end of the liner. The hose set is then inserted into the retraction unit and the retraction speed is set on the control unit. Then the light source is switched on and the retraction is started. When the light source has reached the inversion connection, the light source is switched off and the retraction is stopped.

Description of light-curing system components:

The light-curing system consists of the following components

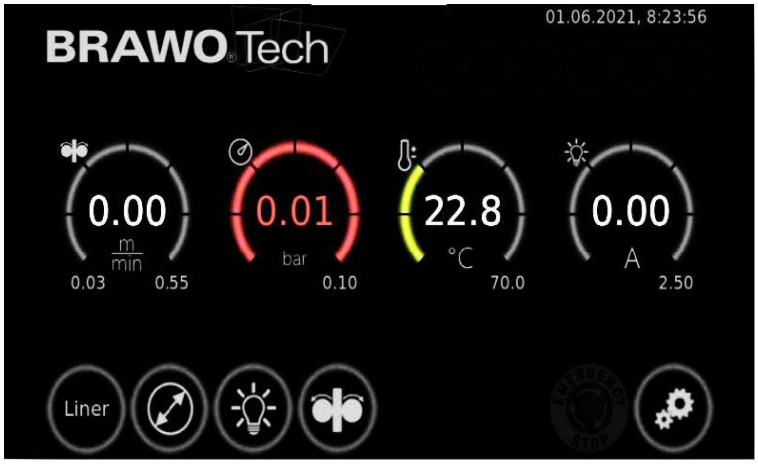
- Control unit
- Retraction unit
- Light source with hose set
- Airlock

Control unit:

The control unit usually contains a monitor for displaying the video image, a control interface with the operating elements and a display for showing the set parameters as well as the measured values of the process.

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

Example of an LED system control unit *(BRAWO® Magnavity SX)*



Example of an LED system control unit (BRAWO® Pico):

Light source with hose set and reel:

A light-curing system may contain several light sources for different pipe diameters. For the BRAWO® Magnavity/SX, for example, the Nano_96 and Mega_192 LED heads are available. Depending on the selected liner type and diameter, the size of the LED head must be selected according to the table on ***Page 22***.

As a rule (not with BRAWO® Pico/SX) there is a camera with suitable lighting at the front end. A temperature sensor to detect the air temperature in the liner and an infrared sensor to detect the temperature on the liner surface are often also part of the equipment.

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

Example of an LED system light source (BRAWO® Pico/SX):

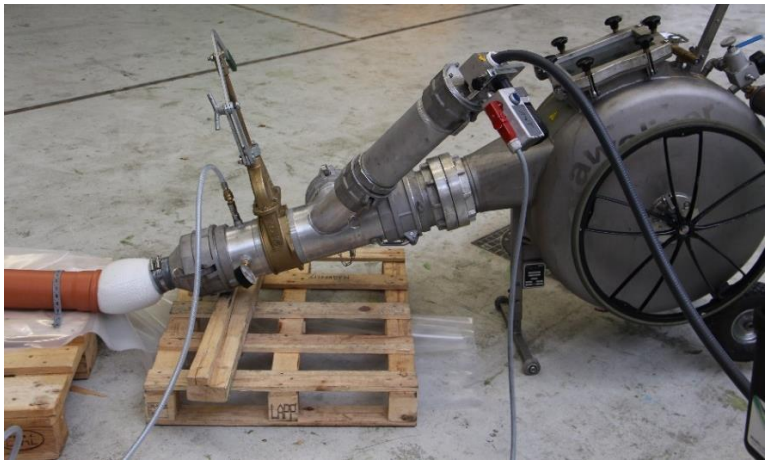
Retraction unit:

The retraction unit is used to pull the hose set back during the curing process. It contains the drive wheels.

Example of a retraction unit (BRAWO® Magnavity SX):

Airlock:

By using the Y-lock with a flat slide valve, two independent pressure ranges can be formed. In the area of the liner, the internal pressure is maintained in the liner during the entire inversion process. Meanwhile, work can be carried out without pressure in the area of the drum. In this pressureless area, once the liner has been half inversed, the LED head of the BRAWO® Magnavity/SX can be coupled to the retaining cup, which was previously attached to the liner knot.



Example of Y-airlock on BRAWO® Magnavity

Example Y-airlock on BRAWO® Pico/SX

When using the BRAWO® Drum 4.0, the use of the Y-airlock is not required. The retaining cup can already be connected with the LED head of the BRAWO® Magnavity/SX when winding up the BRAWOLINER® on the inversion drum.

Example BRAWO® Drum 4.0 with BRAWO® Magnavity SX

4.0.0 Installation process - guideline

These process instructions deal with the BRAWOLINER® method for the **rehabilitation of wastewater pipes** (BRAWOLINER® system) with light-curing resin systems.

ATTENTION!

- **The installation may only be carried out by specially trained qualified personnel.**
- **Pay special attention to *Chapter 2.0.0 "Safety - Accident prevention"* on *Page 5*.**
- **The direction of installation is usually in the direction of flow (with the gradient).**
- **If groundwater is present, the installation pressure must be 0.4 bar above the possible groundwater pressure. The installation of a liner is possible up to a groundwater level of 4 m.**
- **Under no circumstances set an installation pressure > 0.8 bar**
- **The installation recommendations for inversion and curing pressure for the individual liner types on *Page 22* must be observed.**
- **The installation process described below is based on the normal case and is to be understood as a recommendation. Deviations may occur due to circumstances on site and must be recognised by qualified personnel.**

NOTE!

- ***Chapter 4.0.0 "Installation process - guideline"*** **is divided into steps. The sequence listed here is based on the normal case and is to be understood as a recommendation.**
- **The rehabilitation process must be documented. See also *Chapter 6.4.0 "Curing speeds"* on *Page 86* and *Chapter 7.0.0 "Installation log"* on *Page 88*.**

4.1.0 Preparation of the pipe to be renovated

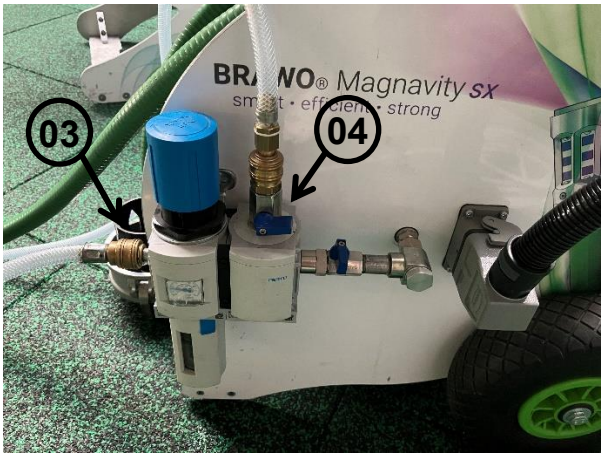
NOTE!

The substrate must be clean and free of loose parts, dust, oil, fats and any other substances that could act as separators.
It can be dry or damp. The base must be stable and evidence a minimum tear strength of min. 1.5 N/mm².

1. High pressure cleaning of the pipe to be renovated.
2. Damage recording with inspection camera.
3. Remove all obstacles with a suitable device, e.g. with a milling robot. The above obstacles could damage the BRAWOLINER® during the installation.
4. Determine the length of the rehabilitation section, record and calibrate the pipe diameters.
5. Measure all inlet pipes. When rehabilitating pipes with differing dimensions or when using a calibration hose, the exact positions of the inlet pipes should be determined, since here the bulging may be less pronounced.
6. If necessary, it is possible to install a preliner in advance of the rehabilitation, see ***Chapter 4.3.0 "Preliner inversion"*** on ***Page 36***.
7. Ensure that no sewage is introduced during the renovation. If necessary, shut off rainwater inlets on collecting pipes.

4.2.0 Establishing operational readiness

1. Place BRAWO® inversion drum / drum 4.0 in position at the start of rehabilitation. If necessary, the inversion drum is provided with a suitable inversion pipe/connection with the airlock for the light source. If nec. get the coupling connector (when using the BRAWO® Drum 4.0), the inversion hose and, if necessary, the Storz coupling key, ready. Connect compressed air connection with the BRAWO® Magnavity/SX(Pos. 03) compressed air distributor. When using an airlock, connect the compressed air connection to the airlock (Pos. 04) with compressed air connection of the airlock.



BRAWO® Magnavity SX

2. Ensure that all ball valves are closed.

3. The retraction unit is positioned behind the airlock or, on the BRAWO® Drum 4.0, on the light/ steam connection port with the light source and, if necessary, the control cable is plugged into the connection provided for this purpose on the control unit.

4. Pull in the pull-in rope (to pull the liner through later).

5. Attach a sufficiently long holding rope to the drum reel with one end and wind it on the axle.

6. Get suitable hose clips, if nec. ball bearing swivels with aramid braided cord, cable ties, adhesive tape and cordless screwdriver ready.

7. Set up the power supply.

8. Prepare BRAWO® impregnation unit - not necessary when using the pre-impregnated BRAWOLINER®.

9. Get the light curing system ready to operate.
10. Check that the installation equipment is functional.

4.3.0 Preliner inversion

CAUTION!

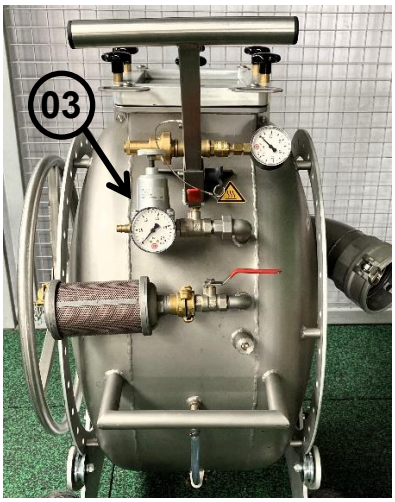
DANGER OF CRUSHING!
Use protective gloves in the area of the handwheel.

The required length of the preliner is dependent on the following factors:

Rehabilitation length + allowance for fastening to the inversion pipe

1. Wind the preliner with open end onto the drum axle. Do not connect the end of the preliner to the retaining strap!
2. With the help of the guide rope, pull the start of the preliner through the inversion connection, inversion hose and the corresponding inversion pipe.
3. Fold the start of the preliner over the inversion pipe and secure with at least two hose clips.
4. Align the inversion pipe towards the pipe being rehabilitated (2nd operator).

5. The 2nd operator gives the signal to start. The 1st operator then opens (is positioned at the BRAWO® inversion drum / Drum 4.0) the compressed air supply at the pressure control valve (Pos. 03). Inversion generally takes place at a pressure of approx. 0.2-0.3 bar. Special local conditions may require different pressures.



BRAWO® Drum 4.0

6. The inversion speed can be adjusted at the pressure control valve (Pos. 03).

7. The inversion of the preliner is finished when the preliner reaches the end of the section under renovation (system pressure is released).

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

9. Open the hose clips on the inversion pipe and attach the preliner to the shaft.

4.4.0 Trim, seal and prepare the calibration hose for inversion

ATTENTION!

Only required if the "open end" installation option is used.

NOTE!

The "open end" installation option is not recommended for diameters DN 50 and DN 70.

The required length of the calibration hose is dependent on the following factors:

	Renovation length
+	**Allowance for attaching to the inversion pipe**
+	**approx. 40 cm for sealing the calibration hose**
+	**Approx. 60 cm safety allowance**
=	**Length of the calibration hose**

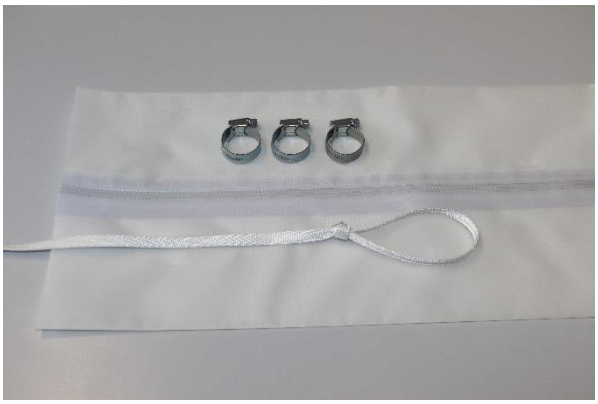
NOTE!

The calibration hose must always be slightly longer than the BRAWOLINER®. Other allowances may be necessary depending on the installation site. However, if the calibration hose extends unprotected too far over the end of the pipe, there is a risk of bursting!

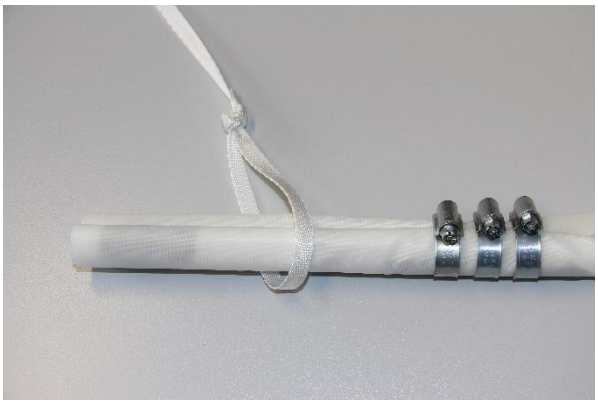
Attention!

When curing with light, a translucent calibration hose must be used.

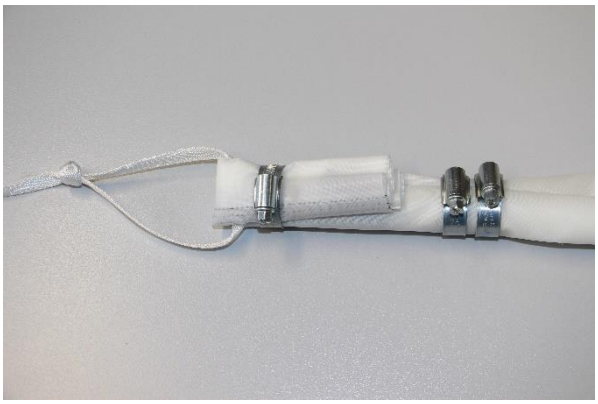
1. Trim the calibration hose.
2. Fold the end of the calibration hose lengthwise.



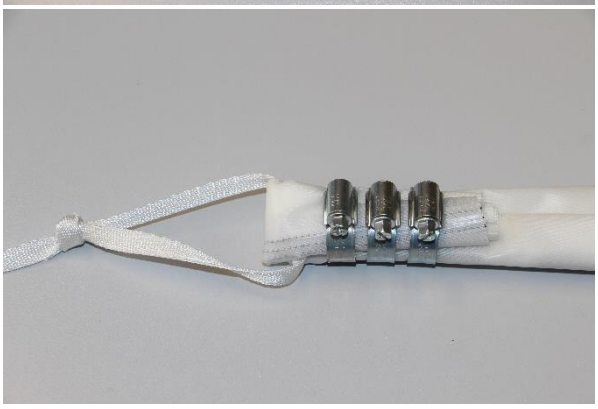
3. Clamp the folded piece loosely with at least three hose clips. Connect retaining strap and calibration hose to each other by means of loops. When using the BRAWO® Magnavity, the magnetic holding cup must also be attached in the loop.



4. Pull the hose clamps over the folded part of the calibration hose.



5. Tighten the hose clamps evenly and tightly.



6. To avoid damage, tape over the hose clamps.

Wind the sealed calibration hose, looped together with the retaining strap, onto the drum axle over the retaining strap.

7. Fasten the start of the calibration hose to the drum axle with adhesive tape. The BRAWOLINER® is then wrapped over it.

4.5.0 Trim BRAWOLINER®, seal it and prepare for impregnation (on-site impregnation)

NOTE!

For trimming and sealing when using the pre-impregnated BRAWOLINER®, follow Chapter 4.7.0 "Trim pre-impregnated BRAWOLINER® and seal it" on Page 52.

The required length of the BRAWOLINER® depends on the selected installation method:

"Closed end":

	Renovation length
+	**Allowance for attaching to the inversion pipe**
+	**Allowance for sealing, vacuum and knot**
=	**Length of the BRAWOLINER®**

"Open end":

	Renovation length
+	**Allowance for attaching to the inversion pipe**
+	**Approx. 20 cm extra for the vacuum exhauster (cut off after impregnation)**
=	**Length of the BRAWOLINER®**

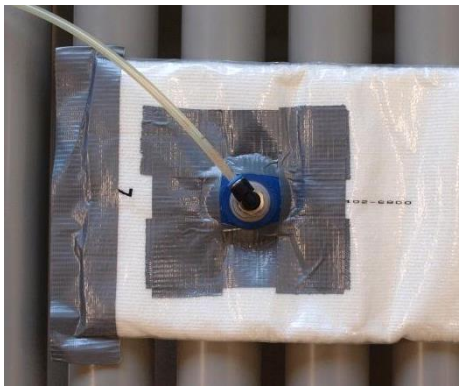
NOTE!

The BRAWOLINER® is a flexible liner. If the inversion pressure is too high, the material may stretch.

1. Lay out the BRAWOLINER® without creases.
2. Trim the BRAWOLINER®.
3. Lay out the BRAWOLINER® on the BRAWO® impregnation unit. The printed arrow must always point from the roller belt towards the impregnation roller.
4. Fold back a rim at the start of the BRAWOLINER® (will be used later for securing to the inversion pipe). The printed arrow must always point from the roller belt towards the folded rim.

5. Seal the end of the BRAWOLINER® airtight with an adhesive tape.
6. At the end of the BRAWOLINER®, make a cut of about 1-2 cm in length in the outer film.

7. Place the suction cup of the vacuum pump on this cut, fix it in place with adhesive tape if necessary and extract the air from the BRAWOLINER® with a vacuum of about 500 mbar.



Small diameters
(e.g. BRAWOLINER® DN 50)

Insert the vacuum hose into the liner end and seal the end airtight with adhesive tape.
Extract air with about 200-300 mbar from the BRAWOLINER®.

4.6.0 BRAWOLINER® impregnation (on-site impregnation)

DANGER!

GHS 07

GHS 09

Light-curing resin systems

- *Causes serious eye damage*
- *Causes skin irritation*
- *Can cause an allergic skin reaction*
- *Can irritate the respiratory tract*
- *Toxic to aquatic life with long lasting effects*

⇨ **Always wear safety goggles and protective gloves.**
⇨ **Do not eat, drink or smoke during work.**
⇨ **Do not inhale dust/smoke/fumes/mist/vapour/aerosols.**

GHS 05

Ensure good ventilation throughout the entire work process.

⇨ **Comply with current safety data sheets.**

ATTENTION!

CAUSTIC EFFECT / HEALTH HAZARD!

- **Safety goggles with side visors or eye protection according to DIN EN 166**
- **Chemical-resistant protective suit**
- **Use chemical-resistant protective gloves tested according to EN 374, e.g. made of nitrile rubber.**
- **BRAWO UVPox*:**
  - **Respiratory protection in case of high concentrations with full mask and filter**
  - **Respiratory protection in case of aerosol and fog formation**
  - **Self-contained breathing apparatus**
- **BRAWO LR: wear type A filter mask, based on the danger and risk of exposure**
- **Comply with the current safety data sheet.**

1. Calculate the necessary amount of resin. See ***Chapter 6.3.0 "BRAWOLINER® resin consumption"*** on ***Page 85.***

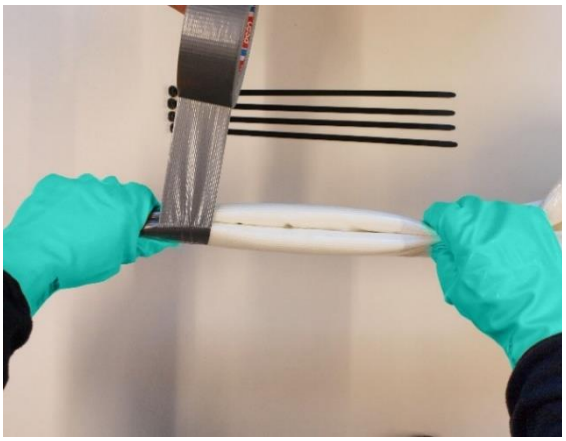
2. Pour resin into the BRAWOLINER®, use a funnel if necessary.
3. Unfold the rim at the filling end again to prevent possible leakage of the resin.
4. Distribute and work in the resin with the BRAWO® impregnation unit. Select and set the roller spacings in accordance with ***Chapter 6.3.0 "BRAWOLINER® resin consumption"*** on ***Page 85***. Normally, one to two roller 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 / Drum 4.0.

4.6.1 Sealing BRAWOLINER® end - "closed end" installation option

1. Seal the end of the BRAWOLINER® airtight.

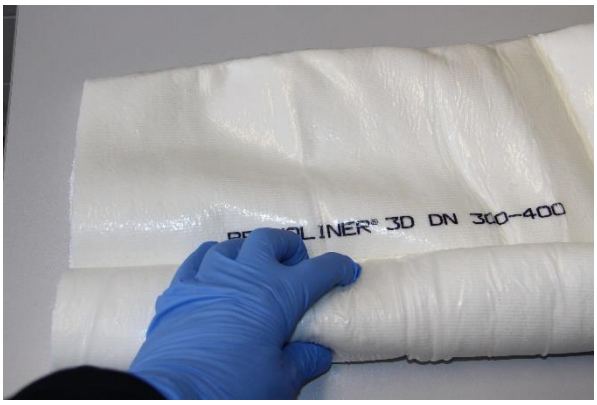
2. Fold the BRAWOLINER® lengthwise and wrap it with adhesive tape.



When using the BRAWOLINER® 3D DN 200-300:

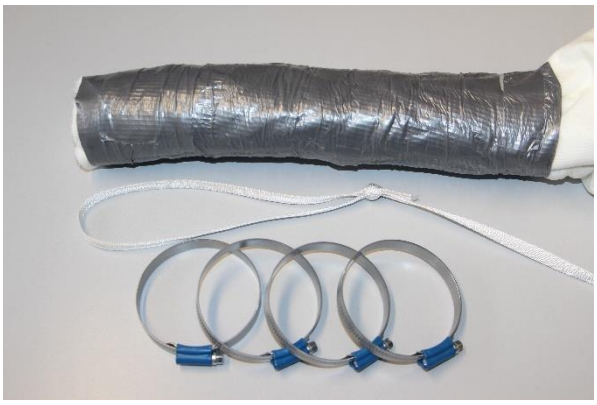
1. Fold the BRAWOLINER® lengthways by half in one direction.

2. Fold the BRAWOLINER® lengthways by half in one direction.



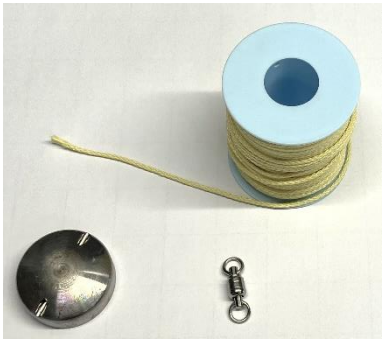
3. Fold the other side of the BRAWOLINER® to form an "S".

4. Fix the "S" in place with fabric adhesive tape, then wrap a piece about 37 cm long tightly with fabric adhesive tape.



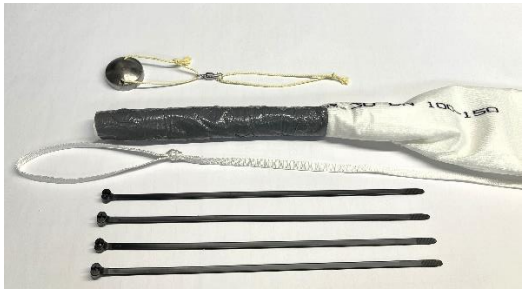
When using the BRAWO® Magnavity/SX with the BRAWO® Drum 4.0:

1. Connect the retaining cup to one side of the ball bearing swivel with an aramid braided cord (not required when using the BRAWO® Drum 4.0). The distance between the retaining cup and the ball bearing swivel should be as small as possible.

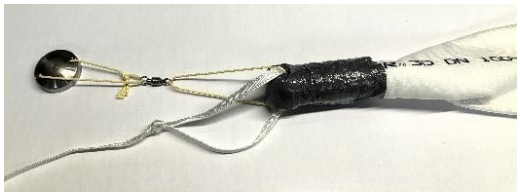


2. Also connect the other side of the ball bearing swivel with an aramid braided cord.

3. Fasten the retaining cup's aramid braided cord and the holding rope to the liner end and fix the liner knots in place with cable ties.



4. Cut the protruding ends of the cable ties off as short as possible and tape over them to prevent damage.



Note: For the BRAWOLINER® 3D DN 200-300, the use of four hose clips instead of cable ties is recommended.

When using the BRAWO® Pico/SX:

1. Insert loop made of retaining strap and pull-in loop into BRAWOLINER® and seal with a cable clamp.

2. Cut the protruding strap of the cable clamp as short as possible and to avoid damage, cover the cable clamp with insulating tape (1.5 cm wide).

3. Completed knot

4.6.2 Sealing BRAWOLINER® end - "open end" installation option

1. Cut off the end of the BRAWOLINER® at the marked liner length (rehabilitation length + allowance for attachment to the inversion pipe). Ensure that the liner is completely saturated with resin past the mark.

2. Fold the BRAWOLINER® lengthwise and pull a rubber glove over it to prevent resin from escaping in the BRAWO® inversion drum / Drum 4.0.

3. Secure the glove with an elastic band. Do not connect with the retaining strap.

4.7.0 Trim pre-impregnated BRAWOLINER® and seal it (factory impregnation)

NOTE!

Protect the pre-impregnated BRAWOLINER® from light, especially direct sunlight, during the entire process.

DANGER!

GHS 07

GHS 09

GHS 05

Light-curing resins

- *Causes serious eye damage*
- *Causes skin irritation*
- *Can cause an allergic skin reaction*
- *Can irritate the respiratory tract*
- *Toxic to aquatic life with long lasting effects*

⇨ **Always wear safety goggles and protective gloves.**
⇨ **Do not eat, drink or smoke during work.**
⇨ **Do not inhale dust/smoke/fumes/mist/vapour/aerosols. Ensure good ventilation throughout the entire work process.**
⇨ **Comply with current safety data sheets.**

ATTENTION!

CAUSTIC EFFECT / HEALTH HAZARD!

- **Safety goggles with side visors or eye protection according to DIN EN 166**
- **Chemical-resistant protective suit**
- **Use chemical-resistant protective gloves tested according to EN 374, e.g. made of nitrile rubber.**
- **BRAWO UVPox*:**
  - **Respiratory protection in case of high concentrations with full mask and filter**
  - **Respiratory protection in case of aerosol and fog formation**
  - **Self-contained breathing apparatus**
- **BRAWO LR: wear type A filter mask, based on the danger and risk of exposure**
- **Comply with the current safety data sheet.**

The required length of the BRAWOLINER® depends on the selected installation method:

4.7.1 "Closed end":

1. Trim the pre-impregnated BRAWOLINER®.

	Renovation length
+	**Allowance for attaching to the inversion pipe**
+	**Allowance for sealing and knot**
=	**Length of the pre-impregnated BRAWOLINER®**

2. Do not use the transport knot of the pre-impregnated BRAWOLINER® for the rehabilitation.

3. Roll resin away from the opening of the BRAWOLINER® (attachment to inversion unit) with a rubberised roller.

4. Seal BRAWOLINER® start with a glove or similar and adhesive tape.

CAUTION!

To protect the light curing system, no leaking resin from the pre-impregnated BRAWOLINER® should get onto the foil of the BRAWOLINER®. trimming the BRAWOLINER® outside the transport carton is recommended.

5. Roll resin away from the opening of the BRAWOLINER® (end knot) with a rubberised roller.

6. Trim approx. 40 cm of transparent calibration hose (e.g. transparent calibration hose, airbag liner, etc.).

7. Fold half of the calibration hose over the liner end and turn the other half of the calibration hose down.

8. Fold the liner end lengthwise and fix it in place with a hose clip.

9. Attach the retaining strap with a loop to the liner end with two hose clips.

10. Wrap the sealed liner end with transparent adhesive tape.

4.7.2 "Open end":

1. Trim the pre-impregnated BRAWOLINER®.

	Renovation length
+	**Allowance for attaching to the inversion pipe**
=	**Length of the pre-impregnated BRAWOLINER®**

2. Do not use the transport knot of the pre-impregnated BRAWOLINER® for the rehabilitation.

3. Roll resin away from the opening of the BRAWOLINER® (attachment to inversion unit) with a rubberised roller.

4. Seal BRAWOLINER® start with a glove or similar and adhesive tape.

CAUTION!

To protect the light curing system, no leaking resin from the pre-impregnated BRAWOLINER® should get onto the foil of the BRAWOLINER®. Trimming the BRAWOLINER® outside the transport carton is recommended.

5. Roll resin away from the opening of the BRAWOLINER® (end) with a rubberised roller.

6. Seal BRAWOLINER® end with a glove or similar and adhesive tape.

4.8.0 Inverting the BRAWOLINER®

DANGER!

During the entire inversion process, neither aerosols (spray cans) nor pressurised gas cartridges with flammable propellants may be used in order to avoid the risk of fire and explosion.

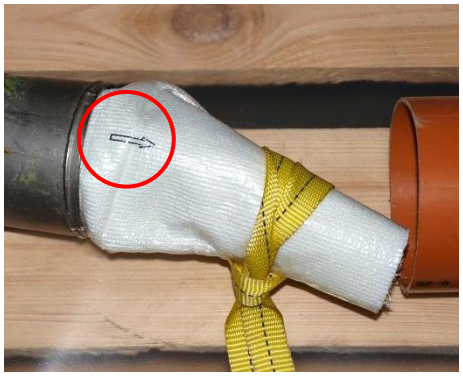
CAUTION!

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

ATTENTION!

- **Wet the impregnated BRAWOLINER® during insertion into the BRAWO® inversion drum / Drum 4.0 again with a lubricant (e.g. silicone oil). This increases the sliding properties of the BRAWOLINER® during inversion. A minimal use of a lubricant is sufficient. Excessive use of the lubricant can be disadvantageous.**

- **Direction of installation: the arrow printed on the liner must always point towards the start of the rehabilitation (pipe start).**



ATTENTION!

- **When installing the BRAWOLINER® 3D with open end, it is particularly important to apply a little lubricant, e.g. silicone oil, to the TPU- film. This prevents "blocking" of the calibration hose, e.g. if there are changes in dimension.**
- **Retaining strap and calibration hose must be already in the BRAWO® inversion drum / Drum 4.0 before winding the BRAWOLINER®!**
- **The installation recommendations for inversion pressures from *Page 22* are to be observed.**

- **In particular, the BRAWOLINER® 3D DN 200-300 must be supported outside the pipe when installed with a closed end:**
  - **between inversion bend and pipe start**
  - **at the pipe end**

  e.g. by means of a suitable calibration hose or support pipe (bear in mind dimension).

CAUTION!

When using the pre-impregnated BRAWOLINER®, protect the tools and equipment from the resin leaking out of the BRAWOLINER®.

When using the pre-impregnated BRAWOLINER®:

1. Protect the inversion connection from leaking resin with adhesive tape or similar.

2. For turning over and fastening the BRAWOLINER® start, remove the liner seal and pull the liner over the inversion connection.

3. Pull calibration hose over the inverted BRAWOLINER® by the inversion connection and fasten with hose clips.

4.8.1 Inversion of the BRAWOLINER® with BRAWO® inversion drum and the BRAWO® Magnavity/SX with airlock

1. Wind the BRAWOLINER® onto the drum axle. The arrow on the surface of the wound liner must point away from the drum axle towards to the inversion connections.

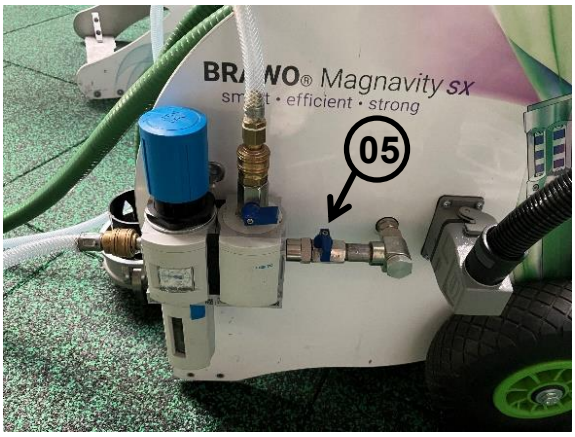
2. With the help of the guide rope, pull the start of the BRAWOLINER® through the inversion connection and the diameter-related inversion pipe.

3. Fold the start of the BRAWOLINER® over the inversion pipe by forming a rim.

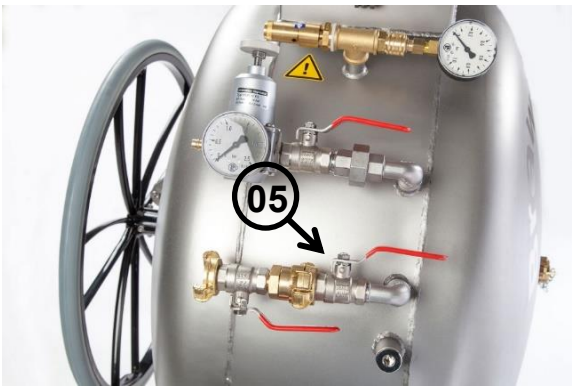
4. Protect the rim against damage with adhesive tape and secure with at least two hose clips to the inversion pipe.

5. Align the inversion pipe towards the pipe being rehabilitated (2nd operator), and position it in the preliner if necessary.

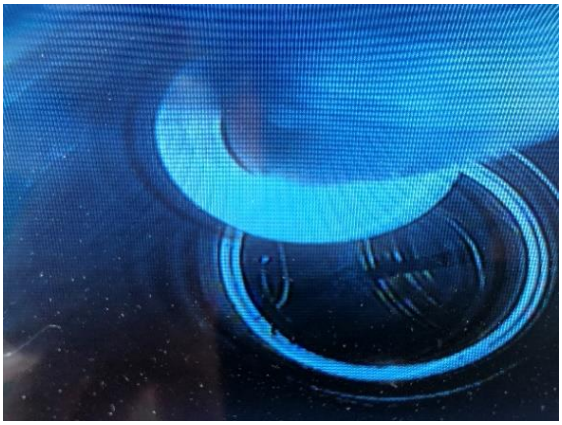
6. The 2nd operator gives the signal to start. The 1st operator then opens the compressed air supply at the ball valve (Pos. 05; Fig.: Example of BRAWO® Magnavity SX). Inversion generally takes place at a pressure of approx. 0.2- 0.3 bar. Special local conditions may require different pressures (see ***ATTENTION!*** on ***Page 33***).

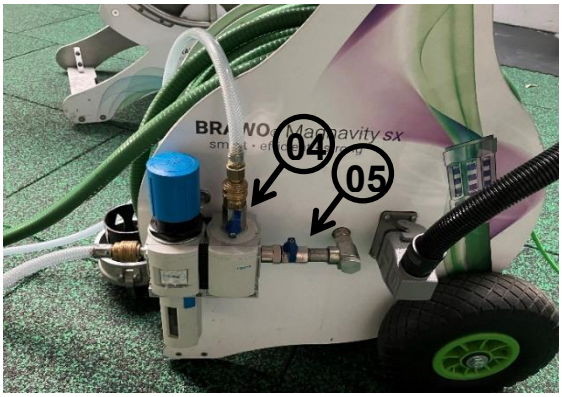


7. The inversion speed can be adjusted at the pressure control valve (Pos. 05) and at the handwheel of the BRAWO® inversion drum.



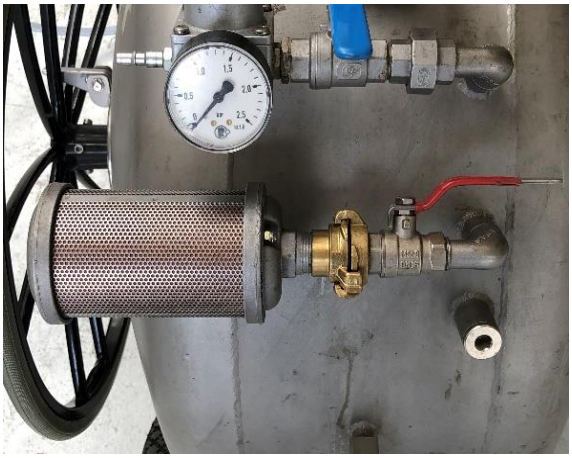
8. The liner is inverted halfway when the retaining cap is just in front of the slider. Once this point is reached, the airlock can be closed. Open the compressed air valve on the BRAWO® Magnavity/SX (Pos. 04) and open the compressed air valve at the airlock. Close the compressed air valve on the BRAWO





9. The pressure release valve on the drum is used to depressurise the area behind the airlock. For safety reasons, the inspection glass on the drum is also opened.

   Observe the liner pressure on the manometer of the airlock and adjust it by means of the airlock's compressed air valve. The liner remains pressurised.

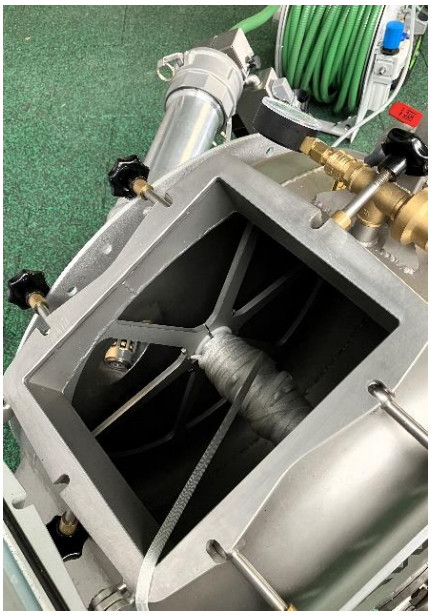


10. If it is ensured that there is no pressure on the rear system, the side cover can be opened and the magnet can be connected to the retaining cup, activate electromagnet via the control system for the BRAWO® Magnavity/SX.

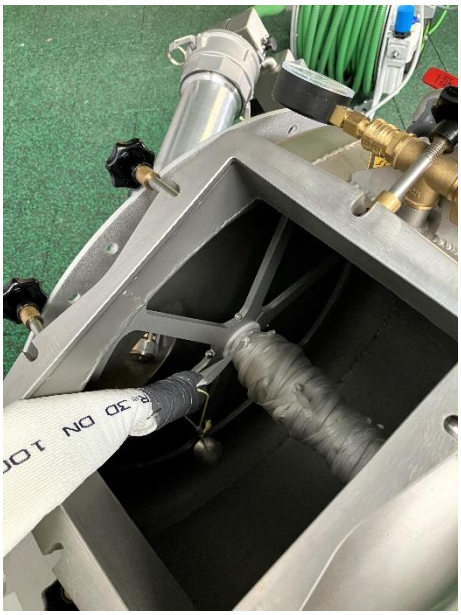
11. The rear system is closed again and pressure equalisation is controlled via the drain valve on the drum. By opening the airlock, both systems are connected. Close the compressed air valve at the airlock. The compressed air for the further inversion process is now supplied via the hose set and the LED head. If nec. the inversion can be supported by activating the retraction unit (push function).

4.8.2 Inversion of the BRAWOLINER® with the BRAWO® Drum 4.0 and the BRAWO® Magnavity/SX

1. Push the LED head to the edge of the connection of the light curing system inside the drum.



2. Wind the holding rope on the drum axis until the BRAWOLINER® end is near the reel.



3. Connect the retaining cup attached to the BRAWOLINER® end with the magnet of the LED head of the BRAWO® Magnavity/SX.
   Activate electromagnet via the control system for the BRAWO® Magnavity/SX.

4. Wind the BRAWOLINER® onto the drum axle. The liner knot must be positioned on the reel side facing the LED head of the light curing system. The arrow on the surface of the wound liner must point away from the drum axle and towards the inversion connection.

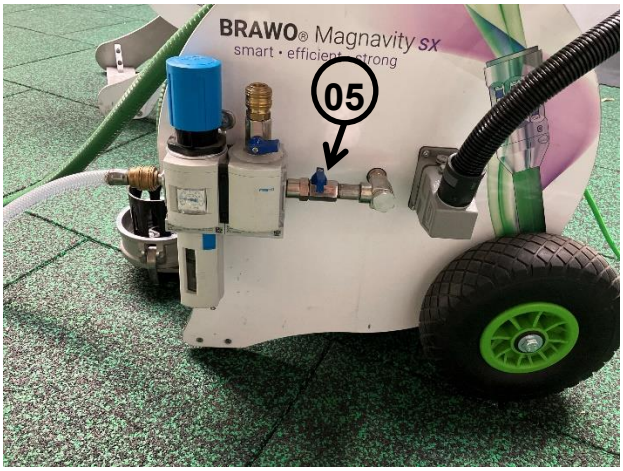
5. With the help of the guide rope, pull the start of the BRAWOLINER® through the inversion connection and the diameter-related inversion pipe.

6. Fold the start of the BRAWOLINER® over the inversion pipe by forming a rim.

7. Protect the rim against damage with adhesive tape and secure with at least two hose clips to the inversion pipe.

8. Align the inversion pipe towards the pipe being rehabilitated (2nd operator), and position it in the preliner if necessary.

9. The 2nd operator gives the signal to start. The 1st operator then opens the compressed air supply at the ball valve (Pos. 05; Fig.: Example of BRAWO® Magnavity SX). Inversion generally takes place at a pressure of approx. 0.2- 0.3 bar. Special local conditions may require different pressures (see ***ATTENTION!*** on ***Page 33***).



10. After the inversion of half of the section, the LED head is also inversed. When doing so, use a 2nd operator to help the hose set of the BRAWO® Magnavity/SX be guided into the BRAWO® Drum 4.0. If nec. the inversion can be supported by activating the retraction unit (push function).

Attention: Figure is used to clarify the process and does not show the real situation with the closed inspection glass on the BRAWO® Drum 4.0.

4.8.3 Inversion of BRAWO® Pico/SX and the BRAWO® inversion drum / Drum 4.0 with airlock

1. The liner is inverted half way.

2. With the help of the pressure relief valve on the drum, the BRAWOLINER® is depressurised. For safety reasons, the inspection glass on the drum is also opened. The liner will collapse.

3. If it is ensured that there is no pressure on the system, the Y-piece can be opened at the inversion connection. The cable lug at the end of the pull-in loop can be inserted into the unlocking device on the BRAWO® Pico/SX head.

4. By opening the compressed air valve on the side part of the BRAWO® Pico/SX, the unlocking device is closed and the liner end is connected to the LED head.

5. The system is sealed again and pressurised. For the further inversion process, the compressed air is supplied via the LED head.

4.9.0 Inverting the calibration hose

4.9.1 Inversion of the calibration hose with BRAWO® inversion drum / Drum 4.0

CAUTION!

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

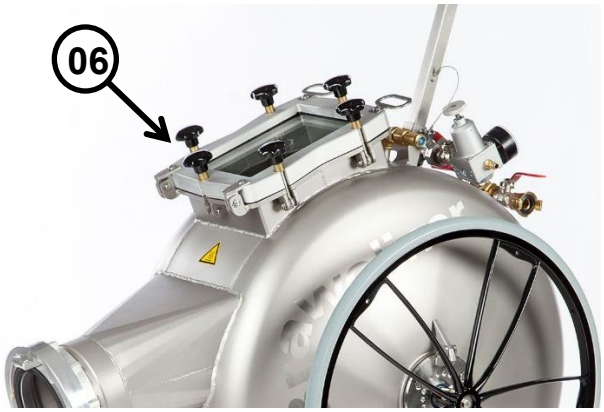
ATTENTION!

RISK OF INJURY DUE TO AIR OVERPRESSURE!
Before opening components, make sure that the system is depressurised.

1. Close the compressed air supply (Pos. 05).

2. Open the hose clip on the inversion pipe, loosen the BRAWOLINER® and secure against slipping.

3. Open the inspection window (Pos. 06) and pull the start of the calibration hose with the guide rope through the inversion connection and the inversion pipe.

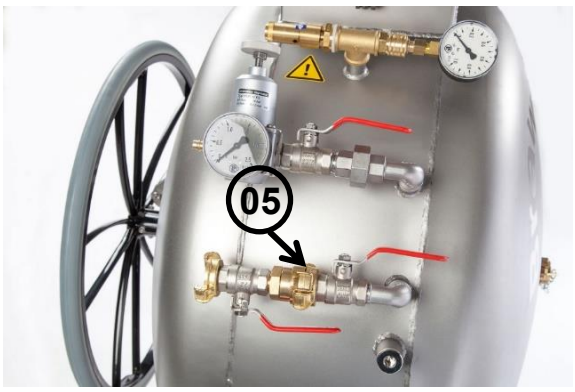


4. Fold the start of the calibration hose over the inversion pipe, secure with adhesive tape and clamp together with the previously inverted BRAWOLINER® using at least two hose clips. Seal the inspection window (Pos. 06) airtight.

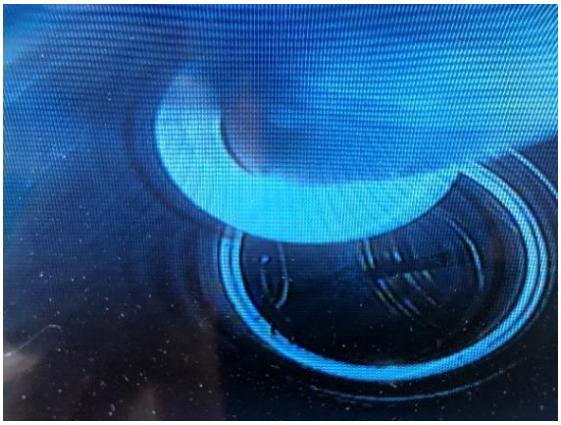
5. Align the inversion pipe towards the pipe being rehabilitated (2nd operator).

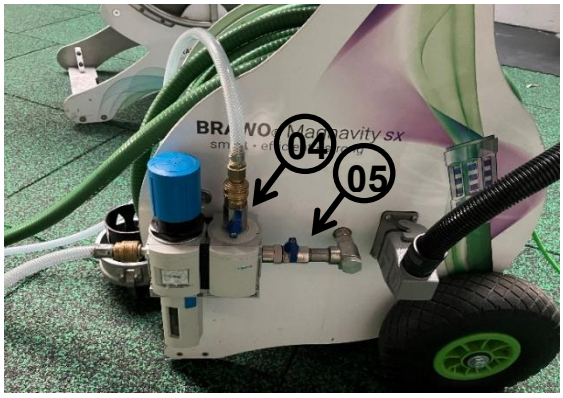
6. The 2nd operator gives the signal to start. The 1st operator then opens the compressed air supply at the ball valve (Pos. 05; Fig.: Example of BRAWO® Magnavity SX). Inversion generally takes place at a pressure of approx. 0.2- 0.3 bar. Special local conditions may require different pressures (see ***ATTENTION!*** on ***Page 33***).

7. The inversion speed can be adjusted at the pressure control valve (Pos. 05) and at the handwheel of the BRAWO® inversion drum.



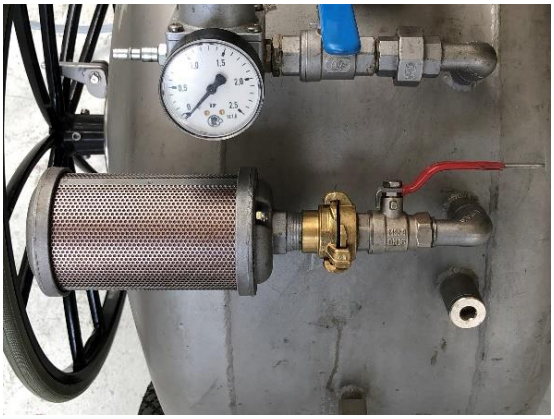
8. The calibration hose is inverted halfway when the retaining cap is just in front of the slider. Once this point is reached, the airlock can be closed. Open the compressed air valve on the BRAWO® Magnavity/SX (Pos. 04) and open the compressed air valve at the airlock. Close the compressed air valve on the BRAWO® Magnavity/SX (Pos. 05).





9. The pressure release valve on the drum is used to depressurise the area behind the airlock. For safety reasons, the inspection glass on the drum is also opened.

   Observe the liner pressure on the manometer of the airlock and adjust it by means of the airlock's compressed air valve. The liner remains pressurised.



10. If it is ensured that there is no pressure on the rear system, the side cover can be opened and the magnet can be connected to the retaining cup, activate electromagnet via the control system for the BRAWO® Magnavity/SX.

12. The rear system is closed again and pressure equalisation is controlled via the drain valve on the drum. By opening the airlock, both systems are connected. Close the compressed air valve at the airlock. The compressed air for the further inversion process is now supplied via the hose set and the LED head. If nec. the inversion can be supported by activating the retraction unit (push function).

4.10.0 End of the inversion of the BRAWOLINER®

4.10.1 "Open end" variant

1. The inversion of the calibration hose is finished when the calibration hose reaches the end of the section under renovation.

ATTENTION!

Once the BRAWOLINER® 3D has been inverted, an increased pressure of min. 0.4 bar must be maintained during the curing process.

2. Lock the handwheel.

3. The pressure in the rehabilitation section must be maintained until the resin has cured. Special local conditions may require different pressures (see ***ATTENTION!*** on ***Page 33***).

4. Curing: see ***Chapter 4.11.0 "Light curing"*** on ***Page 77***.

5. For more information about the subsequent process, see ***Chapter 4.12.0 "Ending the installation - depending on the method"*** starting on ***Page 80***.

4.10.2 "Closed end" variant

1. Inversion is complete 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 curing is complete. Special local conditions may require different pressures (see ***ATTENTION!*** on ***Page 33***).

2. Curing: see ***Chapter 4.11.0 "Light curing"*** on ***Page 77***.

3. For more information about the subsequent process, see ***Chapter 4.12.0 "Ending the installation - depending on the method"*** starting on ***Page 80***.

4.11.0 Light curing

The curing of the laminate with the styrene-free light-curing resin systems BRAWO® LR and BRAWO® UVPox* is carried out by means of suitable curing technology. Gas discharge lamps or LEDs in the wavelength range from 360 nm to 450 nm can be used for curing.

DANGER!

- **UV RADIATION IRRITATES AND DAMAGES THE EYES (RISK OF BLINDNESS)!**
  Protect eyes from UV radiation by wearing UV safety goggles. Do not look into the light sources

- **DANGER OF SKIN BURNS!**
  Protect skin 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 the freely accessible liner and exposed old pipe.

ATTENTION!

The necessary preconditions for using the light-curing system must be observed. The separate operating and maintenance instructions for the light-curing system must be followed.

NOTE!

The light curing system includes a control and retraction unit, a reel and a hose set as well as one or more light sources such as LEDs.

Curing of the hose liner by means of light:

1. Putting the light-curing system into operation:

   Switch on the light-curing system. The operating instructions of the light curing systems (BRAWO® Magnavity, BRAWO® Magnavity SX and BRAWO® Pico/SX) must be observed!

2. Inversing the BRAWOLINER®: see ***Chapter 4.8.0 "BRAWOLINER® inversion"*** starting from ***Page 58*** or, with the open end, the inversion of the calibration hose. See ***Chapter 4.9.0 "Inverting the calibration hose"*** starting from ***Page 72.***

3. For the BRAWO® Magnavity/SX and BRAWO® Pico/SX, retraction speeds are suggested according to the pipe diameter and the selected BRAWOLINER®. These can be adjusted manually. The appropriate retraction speed (see ***Chapter 6.3.0 "Curing speeds"*** on ***Page 85***) is set on the control unit. The set value is shown on the display on the control unit.

NOTE!

Pay attention to information on the retraction speeds in different pipe dimensions and different BRAWOLINER® types.
See *Chapter 6.4.0 "Curing speeds"* on *Page 85* and technical data sheet for light-curing resins.

4. Switch on the light source. When using the BRAWO® Magnavity/SX, also switch off the magnet. When using the BRAWO® Pico/SX, close the compressed air valve on the side part of the BRAWO® Pico/SX.

5. Start the retraction unit. The retraction speed is shown on the display. In addition, the retraction of the light source can be monitored with the integrated camera via the display in the control unit (only with BRAWO® Magnavity/SX). During curing, reaction heat is generated in the laminate. The process temperatures can be followed on the display.

6. After the light source has been pulled completely through the pipe, switch off the light source and stop the retraction.

NOTE!

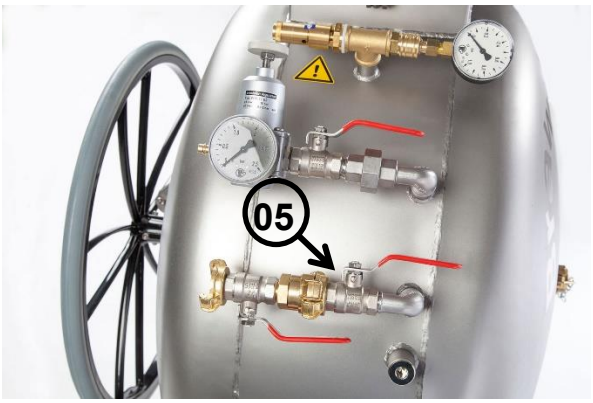
Maintain the compressed air supply for at least 10 minutes after switching off the LED head or until the LED head has cooled to a temperature ≤ 30 °C.

7. Switch off the control unit.

8. For more information about the subsequent process, see ***Chapter 4.12.0 "Ending the installation - depending on the method"*** starting on ***Page 80***.

4.12.0 Ending the installation - depending on the method

Installation with "closed end":

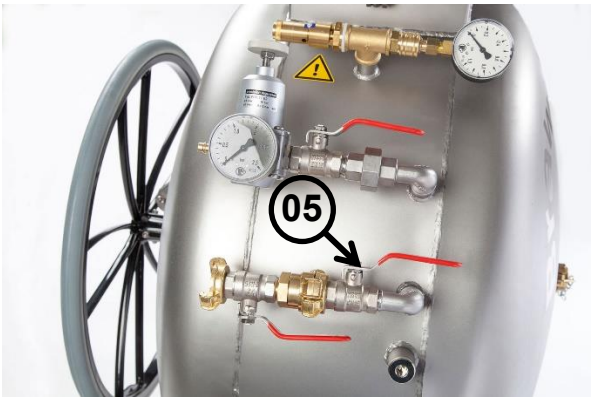


1. After curing and cooling is complete, release the system pressure (open ball valve Pos. 05).
2. Open the hose clips on the inversion pipe.
3. Cut the BRAWOLINER® off flush with the old pipe. Smooth out any unevenness in the base area if necessary (e.g. with cement mortar).
4. Open any sealed inlet pipes with a suitable tool.
5. If necessary, connect transition areas securely with suitable procedures, especially inside buildings.

- The installation variant you selected is now completed -

Installation with "open end":

1. After curing and cooling is complete, pull the calibration hose under a low pressure (approx. 0.05 bar) out of the BRAWOLINER® by folding it back with the help of the retaining strap.



2. After retraction is complete, release the system pressure (open ball valve Pos. 05).
3. Open the hose clips on the inversion pipe.
4. Cut the BRAWOLINER® off flush with the old pipe. Smooth out any unevenness in the base area if necessary (e.g. with cement mortar).
5. Open any sealed inlet pipes with a suitable tool.
6. If necessary, connect transition areas securely with suitable procedures, especially inside buildings.

- The installation variant you selected is now completed -

5.0.0 Maintenance and servicing

ATTENTION!

- **The data regarding the obligatory maintenance and inspection intervals can be found in the respective operating and maintenance instructions of the individual machines and devices.**
- **Defective parts are always replaced by original accessories from the company BRAWO® SYSTEMS GmbH. Only this ensures the correct operation of the machine/system.**
- **The maintenance, repair and serving work may only be carried out by authorised specialist personnel.**
- **Comply with the applicable occupational health and safety and accident prevention regulations.**
- **Ensure that operating and auxiliary materials, as well as replaced parts, are disposed of in a safe and environmentally sound manner!**

6.0.0 Important information about reaction resins

The styrene-free light-curing resin systems used are so-called reaction resins.

6.1.0 What are reaction resins?

Reaction resins are processed in their liquid state at the construction site. They harden in a relatively short time by means of a chemical reaction. With the right composition, reaction resins can achieve high mechanical strength and good resistance against chemicals and climatic influences.

6.2.0 Manufacturing instructions

ATTENTION!

Comply with the technical data sheets and safety data sheets of the corresponding resins. They can be found, for example, in the download area on www.brawosystems.com.

ATTENTION!

Do not expose the resin to direct sunlight or UV light during preparation and processing, as this will cause the resin to harden!

Safety regulations must be complied with when working with these resins. See *Chapter 2.4.0 "Sources of danger - Accident prevention"* on *Page 8*.

Storage:

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

Processing temperature:

To ensure optimum processability, we recommend tempering the resin to +15 °C before processing.

6.3.0 BRAWOLINER® resin consumption

BRAWOLINER ®

DN	To achieve min. 3 mm wall thickness		Reduced wall thickness min. 2 mm (In-house)	
	Roller spacing	BRAWO® LR / BRAWO® UVPox in kg / m	Roller spacing	BRAWO® LR / BRAWO® UVPox in kg / m
50			4.0	0.3
70			6.5	0.6
100	8.5 mm	1.1		1.0
125		1.4	7.0	1.2
150		1.7		1.5
200		2.3		2.0

BRAWOLINER ® 3D

DN	To achieve min. 3 mm wall thickness		Reduced wall thickness min. 2 mm (In-house)	
	Roller spacing	BRAWO® LR / BRAWO® UVPox in kg / m	Roller spacing	BRAWO® LR / BRAWO® UVPox in kg / m
70 – 100	10.0 mm	0.9	6.5	0.6
100 – 150	12.0 mm	1.5	10.0	1.4
150 – 225		2.3		2.2
200 – 300	14.0 mm	4.1		

BRAWOLINER ® XT

DN	To achieve min. 4 mm wall thickness	
	Roller spacing	BRAWO® LR / BRAWO® UVPox in kg / m
150	11.0 mm	2.3
200		3.1

All data is to be understood as approximate and is based on experimentally determined values. Deviations depending on ambient conditions are possible.

6.4.0 Curing speeds

6.4.1 BRAWO® Pico and BRAWO® Pico SX curing speeds

Liner	DN	Retraction speed in m/min
BRAWOLINER® DN 50	50	0.5
BRAWOLINER® DN 50	70	0.4
BRAWOLINER® DN 70	70	0.3
BRAWOLINER® 3D DN 70-100	70	0.3
BRAWOLINER® 3D DN 70-100	100	0.4
BRAWOLINER® DN 100	100	0.3

The operating instructions for the BRAWO® Pico/SX system must be observed.
All data is to be understood as approximate and is based on experimentally determined values.

6.4.2 BRAWO® Magnavity and BRAWO® Magnavity SX curing speeds

Liner	DN	Retraction speed in m/min	
		Nano_96 LED head	Nano_96 LED head
BRAWOLINER® 3D DN 70-100	70	0.6	-
BRAWOLINER® 3D DN 70-100	100	0.6	-
BRAWOLINER® DN 100	100	0.6	-
BRAWOLINER® DN 125	125	0.6	0.7
BRAWOLINER® DN 125	150	0.6	0.8
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® DN 150	150	0.6	0.7
BRAWOLINER® XT DN 150	150	0.5	0.6
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® DN 200	200	0.4	0.7
BRAWOLINER® DN 200	225	0.4	0.7
BRAWOLINER® DN 200	250	0.4	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® 3D DN 200-300	200	-	0.6
BRAWOLINER® 3D DN 200-300	225	-	0.5
BRAWOLINER® 3D DN 200-300	250	-	0.4
BRAWOLINER® 3D DN 200-300	300	-	0.3

The operating instructions for the BRAWO® Magnavity/SX system must be observed.
All data is to be understood as approximate and is based on experimentally determined values.
When using a translucent calibration hose, BRAWO® Magnavity/SX can be selected in the “liner” menu using the “+CAL” button. When this button is confirmed, the return speed is reduced by half of the value given in the table.

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

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	150	0.3	0.2
BRAWOLINER ® XT	200	0.2	0.1

The operating instructions for the curing unit used must be observed.
All data is to be understood as approximate and is based on experimentally determined values.
In case of failure of a light source, the retraction speed is to be reduced proportionally (e.g.: if a light source in a chain of 3 fails, the retraction speed is reduced by 1/3)

7.0.0 Installation log

The installation protocol example shown in the appendix is a recommendation on our part and contains all essential details to be able to track the renovation at a later point in time.

installation protocol

BRAWOLINER® light curing

date

sheet

project

project no. | order no. | description

street / zip code / city

comments

client

customer | contact person | street / zip code / city

installation team

deployment manager | personnel | col. vehicle

object

sewer pipe | material | number and location of inlets | pipe length [m]

dimension | bends | type of damage

accomplished

☐ TV preliminary inspection ☐ TV post-inspection ☐ HP cleaning

☐ calibration ☐ daytime cordoning off ☐ milling work

shaft

from shaft | shaft depth [m] | diameter [m]

to shaft | gradient (height difference) [m] | groundwater level [m]

material

material specification by ☐ contractor ☐ contractor - site manager ☐ contractor - polisher

comments

liner

☐ BRAWOLINER® ☐ BRAWOLINER® 3D ☐ BRAWOLINER® XT ☐ other

dimension | batch no.

resin resin selection

☐ BRAWO® LR ☐ BRAWO® UVPox50 ☐ BRAWO® UVPox51 batch no.

installation ☐ waste water-free ☐ precipitation ambient temperature [°C]

install with ☐ preliner ☐ calibration hose **liner end** ☐ open ☐ closed

impregnation ☐ on-site ☐ pre-impregnated

resin storage temp. [°C] target 5-25 °C | resin total target [kg]

resin temp. before install. [°C] target 15-20 °C | resin total [kg]

vacuum [bar] target 0,5 bar, 5 min. before and during | resin quantity [kg/m]

roller spacing target [mm] | actual roller spacing [mm]

inversion inversion pressure [bar] target 0,2-0,3 bar

curing ☐ test UV/LED lights

Used UV unit ☐ BRAWO Magnavity (SX) ☐ BRAWO Pico (SX) ☐ other UV unit

number / power of UV lights ☐ 1x 250 W LED head nano ☐ 1x 500 W LED head mega ☐ other

retraction speed target [m/min] actual [m/min]

curing pressure [bar] target 0,3-0,4 bar pressure hold time [min] target 10 min

sketch & comments