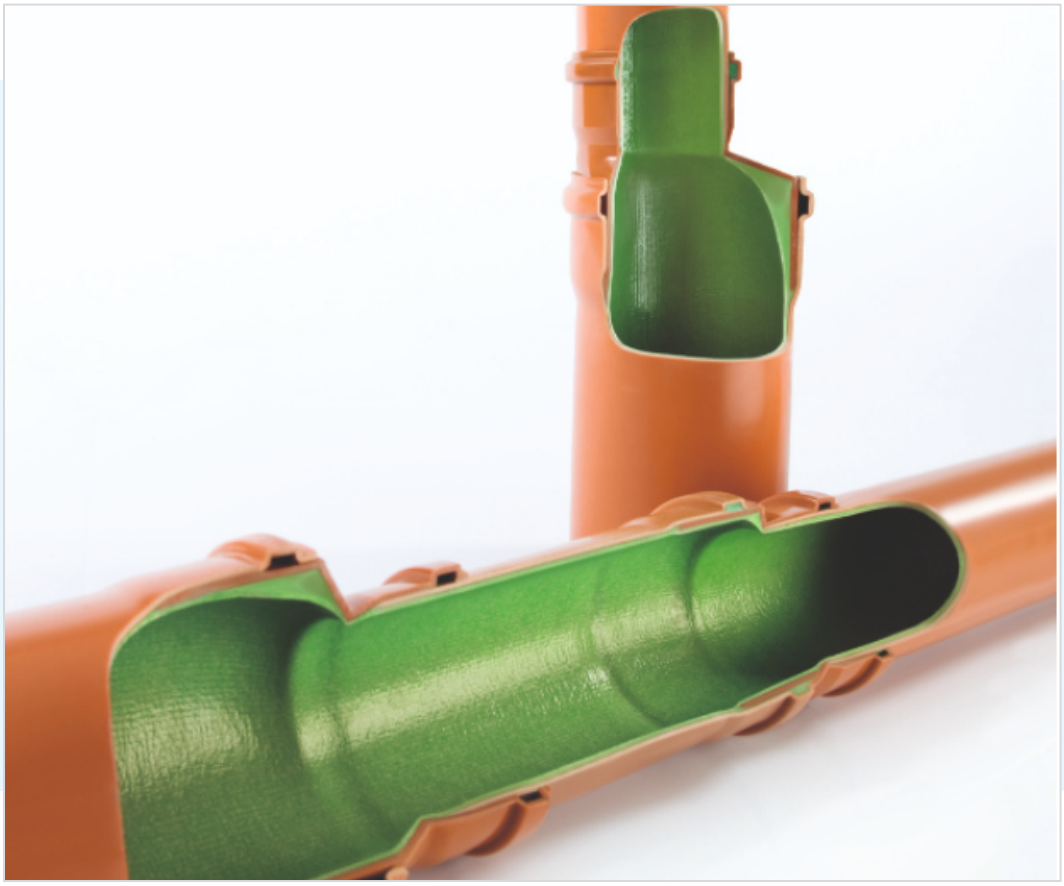
BRAWO SYSTEMS

Process Instructions

BRAWOLINER® Rehabilitation Process



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Please retain for future use!

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Table of Contents

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** an**d 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.

Specific details for economical use and important additional information.

2.2.0 Intended Use

- The BRAWO® inversion drum/BRAWO® Tripod 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.

- Proper intended use also includes compliance with inspection and maintenance conditions and following 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

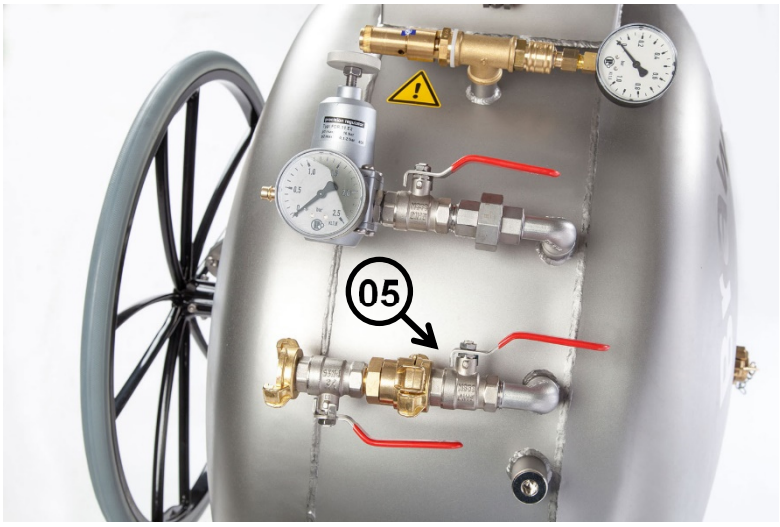
The machines and devices used in the inversion process are built to the newest state of technology and the recognized safety-related regulations. This presumes that corresponding work protection and accident prevention regulations are followed.

However, the following residual dangers exist when handling the:

- **BRAWO® Inversion drum**

CAUTION!

DANGER OF CRUSHING!
Wear protective protective gloves in the area of the handwheel.
In emergency situations release pressure: Open “pressure release” ball valve pos. 05 – the system pressure escapes.



- **BRAWO® Tripod**

DANGER!

- **RISK OF SCALDING!**
  from hot water
- **RISK OF TIPPING!**
  Always ensure a secure positioning of the BRAWO® Tripod.
- **RISK OF FALLING!**
  when working on scaffolding and ladders

- **Epoxy resin**

DANGER!

GHS 05

GHS 07

GHS 08

GHS 09

- *Causes serious chemical burns of the skin and severe eye damage.*
- *Causes skin irritation.*
- *Can damage the organs in case of extended or repeated exposure.*
- *Causes severe eye irritation.*
- *Hazardous to health if swallowed.*
- *Can presumably impair fertility. Can presumably cause harm to the unborn child.*
- *Toxic to water organisms with long-term effects.*

⇨ **Wear protective gloves/eye protection/ face shield.**
⇨ **Do not, eat, drink or smoke while working.**
⇨ **Avoid inhalation of dust/smoke/gas/fog/vapor/aerosol.**
⇨ **Avoid releasing in the environment.**
⇨ **Ensure good ventilation during the mixing process.**
⇨ **Follow current safety data sheets.**

- **BRAWO® HotBox**

DANGER!

- **RISK OF POISONING BY EXHAUST GASES!**
  Install the BRAWO® HotBox outside or ensure adequate removal of exhaust gases into the outside.
- **RISK OF FIRE!**
  Never cover the exhaust gas chimney.

CAUTION!

RISK OF BURNS!
due to hot parts.

- **BRAWO® SteamUnit**

DANGER!

- **RISK OF POISONING BY EXHAUST GASES!**
  Install the BRAWO® SteamUnit outside or ensure adequate removal of exhaust gases into the outside.
- **RISK OF FIRE!**
  Do not cover hot parts, never cover the exhaust chimney.

WARNING!

- **RISK OF SCALDING!**
  due to hot water or steam.

CAUTION!

- **RISK OF BURNS!**
  due to hot parts.
  Standing in the shaft during installation and curing of the liner is fundamentally to be avoided. Especially with warm curing, there is the risk of injuries in the case of a bursting, especially scalding.

WARNING!

2.4.2 Personal Protective Equipment

When handling:

- **BRAWO® Inversion drum**

ATTENTION!

DANGER OF CRUSHING!
Wear protective gloves.

- **Epoxy resin**

ATTENTION!

CAUSTIC EFFECT / RISK TO HEALTH!

- **Face protection**
- **Or tightly sealed safety glasses.**
- **Appropriate protective clothing, e.g. chemical resistant protective suit**
- **Chemical-resistant protective gloves tested acc. to EN 374, 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.

- **BRAWO® SteamUnit**

ATTENTION!

BURNING AND SCALDING RISK!

- **Face protection**
- **Or tightly sealed safety glasses**
- **Wear protective gloves.**

2.4.3 First Aid measures (epoxy resin)

- **General instructions:**

  Epoxy resin can cause chemical burns 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:**

  Ample fresh air supply and as a precaution see a doctor. If unconscious, place in a stable side position, also for transport.

- **After contact with the skin:**

  Wash with soap and water immediately and rinse well.
  Do not use thinner or solvent to clean the skin.
  See a doctor in case of extensive skin contact, rashes or itching.

- **After contact with the eyes:**

  Contact a physician immediately. Rinse the eyes with opened eyelids under running water.

- **After swallowing:**

  Contact a physician immediately. Rinse mouth with water. Drink large quantities of water and ensure fresh air supply.

For more see BG practical guide for handling epoxy resins and safety data sheets of BRAWO® Resins.

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

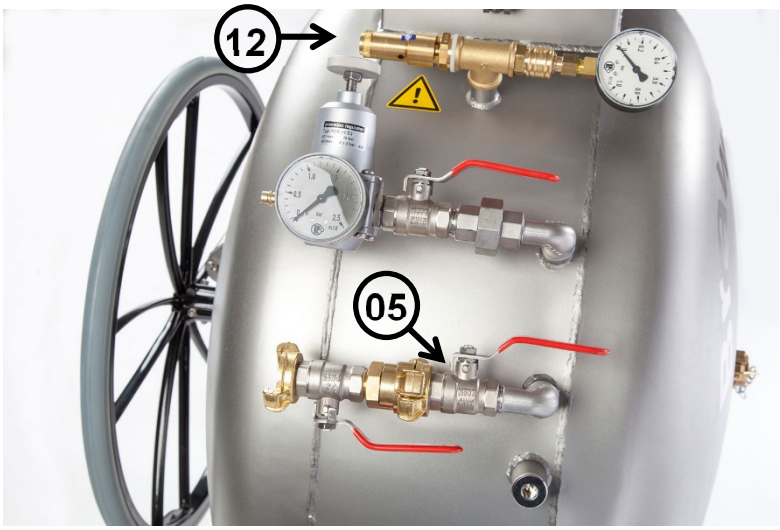
Poison emergency center (+49) 6131 19240

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.**
- **Release the pressure and disconnect all auxiliary devices from the BRAWO® inversion drum before service, repair and maintenance work.**

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 tasked to do inversion processes.

2.6.0 Noise Emission

The A-weighted equivalent continuous sound pressure level of the BRAWO® inversion drum, the BRAWO® impregnation system, BRAWO® HotBox, BRAWO® SteamUnit and circulation 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®** System covers the trenchless rehabilitation of house connection lines, as well as the rehabilitation without breaking up of down pipes and connection lines inside of buildings. Channels and piping systems in the dimensions of DN 50 to DN 400, also with bends and dimension changes, can be rehabilitated.

3.2.0 Brief description of the BRAWOLINER® inversion process

The installation method is approved by the Deutschen Institut für Bautechnik (DIBt) (German Institute for Structural Engineering).

DIBt approval no:. Z-42.3-362 (DN100 - DN400)
(Rehabilitation of underground damaged waste water lines)

DIBt approval no:. Z-42.3-499 (DN50 - DN200)
(Rehabilitation of damaged sewer, rainfall and collection lines inside buildings).

Damaged piping systems must be prepared appropriately (cleaned, etc.) before inversion. The **BRAWOLINER®** is impregnated with epoxy 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.

- **Installation with BRAWO® Tripod (gravity of water)**

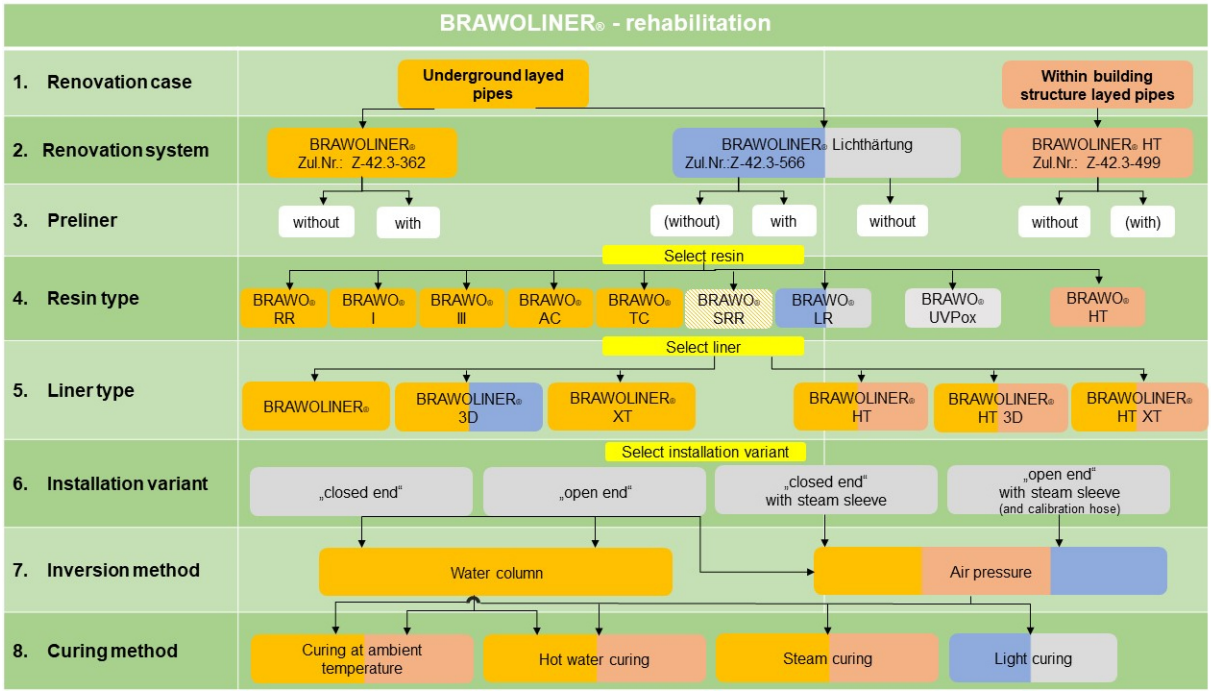
  The pretreated **BRAWOLINER®** is placed in the BRAWO® Tripod and inverted into the damaged pipe using hydrostatic pressure.

This places the **BRAWOLINER®** against the existing pipe walls. The curing time for epoxy resins are dependent on the ambient temperature and can fluctuate very strongly. Refer to ***section 7.0.0 "Things to know about reaction resins"*** on ***page 94***.

By using our optionally available warm water heating system (BRAWO® HotBox) or steam heating system (BRAWO® SteamUnit) very short and constant curing times can be achieved.

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

3.3.0 Schematic flow diagram



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 sub-sections, and help in the selection of the suitable variant in individual cases.

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

ATTENTION!

Waste water lines with pipe bulkheads, which expand in case of fire (e.g. pipe collars) must not be rehabilitated. The provisions of the guideline for fire protection regulations on piping systems of the respective federal states must be taken into consideration.

3.3.2 Rehabilitation system

Basically the **BRAWOLINER®** process can be divided into two areas:

1. BRAWOLINER® system

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

DIBt approval number: Z-42.3-362

2. BRAWOLINER® HT-system

The **BRAWOLINER® HT** system is used for the rehabilitation of damaged waste water lines (sewer, rainfall and collection lines) ***inside*** the building structure.

DIBt approval number: Z-42.3-499

NOTE!

The difference of the rehabilitation systems is only in the materials used and possibly in the curing method.

Requests for waste water lines in the interior of houses requires the use of the **BRAWOLINER® HT** rehabilitation system.

3.3.3 Preliner

NOTE!

- **A preliner must be inserted in advance of the rehabilitation in zones saturated with groundwater (ground water infiltration).**
- **For the rehabilitation of down pipes the use of a preliner is not recommended, since here no adhesion with the old pipe can be done with this.**

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 4.3.0 "Inverting the preliner"*** on ***page 35***.

3.3.4 Resin types

Depending on the requirement the following resins can be selected:

Resin types and areas of use										
BRAWO® Resin type	Buried lines	House internal lines	Connection nozzle	Line length			Processing time Saturated liner	Curing time Cold curing	Curing time Warm curing 50°C	Curing time Warm curing 70°C
				shorter than 5 m	shorter than 15 m	longer than 15m				
BRAWO® RR *)**	X		X	(X)			30 min at 15°C	6 h at 10°C	75 min	-
BRAWO® SRR *)**	X		X	(X)			30 min at 15°C	2 h at 20°C	30 min	-
BRAWO® I	X		X	X	X	(X)	50 min at 15 C	13 h at 10°C	100 min	45 min **)
BRAWO® III	X		X	X	X	X	3.5 h at 15 C	24 h at 10 C	220 min	140 min **)
BRAWO® AC*)	X		X	X	X	(X)	2-2.5 h at 15°C	24 h at 10 C	220 min.	140 min.
BRAWO® TC*)	X				X	X	8 h at 15°C	-	-	300 min.
BRAWO® HT		X	X	X	X	X	70 min at 20°C	18 h at 15 C	140 min	80 min **)

*) Only usable for BRAWOLINER® 3D DN 300-400

**) Only in combination with BRAWOLINER® HT or with a suitable calibration CIPP

***) Caution: When curing BRAWO® RR and BRAWO® SRR with steam, there is a risk of extreme temperature development as a result of the exothermic resin reaction. Therefore, curing with steam is not recommended.

(X) Limited processing time Only recommended with favorable conditions

NOTE!

- **Mixing ratio BRAWO® RR/ SRR/ I/ III/ AC: 3:1 (Mass fraction component A:B)**
- **Mixing ratio BRAWO® HT: 5:1 (Mass fraction component A:B)**
- **Mixing ratio BRAWO® TC: 100:42 (Mass fraction component A:B)**
- **Excessive reaction temperatures must be avoided (exothermic).**

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 94***.

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 type	Liner designation	Buried Lines	House internal Lines	Steam Curing	Ø 50	Ø 70	Ø 80	Ø 100	Ø 120	Ø 150	Ø 175	Ø 200	Ø 225	Ø 250	Ø 300	Ø 350	Ø 400
BRAWOLINER®	DN 50	X		X *)	X	X											
	DN 70/80	X		X *)		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	X			
XT	DN 100	X		X *)				X	X								
	DN 125	X		X *)					X	X							
	DN 150	X		X *)						X	X						
	DN 200	X		X *)								X	X	X			
3D	DN 70-100	X		X *)		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		
	DN 300-400	X		X											X	X	X
BRAWOLINER® HT	DN 50	X	X	X	X	X											
	DN 70/80	X	X	X		X	X										
	DN 100	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	X			
HT 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	X			
HT 3D	DN 70-100	X	X	X		X	X	X									
	DN 100-150	X	X	X				X	X	X							
	DN 150-225	X	X	X						X	X	X	X				

*) With the use of a suitable calibration CIPP

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 / HT / XT HT	approx.0.2	approx.0.4	min.0.4
BRAWOLINER® 3D / HT 3D (DN 70-300)	approx.0.2	approx.0.4*	min. 0.4*
BRAWOLINER® 3D DN 300-400	approx. 0.1	approx.0.2	approx. 0.2

*The heating is favorable for the expansion. With light curing possibly a higher curing pressure must be used.

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 31 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.**
- **For the curing with water the height differences between start and target point must be taken into account.**

3.3.6 Installation variants

There are 4 variants to design the ends of the **BRAWOLINER®** and the calibration CIPP, which are dependent upon the accessibility of the line end and the curing type.

- During the warm curing (water), an additional CIPP (Ø approx. 20 mm, one-side GEKA-connection, water outlet on **BRAWOLINER®** end) is required for circulation.
- For the steam curing the BRAWO® steam sleeve is installed in the **BRAWOLINER®** or calibration CIPP to enable a flow and drain condensate.

For detailed instructions for designing the knots and integrating the **BRAWO® steam sleeve, refer to section 4.4.0 „Close the BRAWOLINER® end starting on page 49.**

3.3.6.1 Calibration CIPP

The calibration CIPP is a 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.

It can be used as additional protection of the liner film during steam curing. During heat curing it must be ensured that a temperature-resistant calibration CIPP is used.

For more detail on the installation process, refer to the ***section 4.9.1 "Inversion of the calibration CIPP with BRAWO® inversion drum"*** on ***page 69***.

3.3.6.2 Installation variant “closed end”

Application with:

- **BRAWOLINER®** end accessible
- **BRAWOLINER®** end **not** accessible, milling robot required
- Cold curing or heat curing with water

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 (+ CIPP during hot curing) on the **BRAWOLINER®** end

3.3.6.3 Installation variant “open end”

Application with:

- **BRAWOLINER®** end **not** accessible
- Cold curing or heat curing with water

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 (+ CIPP during hot curing) on the calibration CIPP end

3.3.6.4 Installation variant "BRAWO® steam sleeve in the BRAWOLINER® HT"

Application with:

- **BRAWOLINER®** end accessible
- Hot curing with steam

This variant can be used during hot curing using steam if there is a possibility of opening the end. The BRAWO® steam sleeve is fastened in the end of the **BRAWOLINER® HT** so that steam and condensate can escape. A continuous volume flow must be introduced to maintain the contact pressure in the pipe.

Type of structure:

- ⇨ "BRAWO® steam sleeve in the **BRAWOLINER® HT**"
- ⇨ No calibration CIPP required
- ⇨ Fasten the retaining strap on the **BRAWOLINER® HT** end

3.3.6.5 Installation variant "Open end BRAWOLINER® / BRAWO® steam sleeve in the calibration CIPP"

Application with:

- **BRAWOLINER®** end **not** accessible
- Hot curing with steam

This variant can be used during hot curing using steam if there is ***no*** possibility of opening the end. 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. The BRAWO® steam sleeve is fastened in the end of the calibration CIPP so that steam and condensate can escape. A continuous volume flow must be introduced to maintain the contact pressure in the pipe.

Type of structure:

- ⇨ "Open end" **BRAWOLINER®**
- ⇨ BRAWO® steam sleeve in the calibration CIPP end
- ⇨ Fasten the retaining strap on the end of the calibration CIPP

3.3.7 Required installation equipment

Necessary equipment:

1. Compressor (min. 1300 l/min during steam curing)
2. Power generator (approx. 3 kW), alternatively power supply 230V
3. Rechargeable screwdriver
4. Inspection camera

Always required:

1. **BRAWOLINER® / BRAWOLINER® HT**
2. BRAWO® Resin
3. Stirrer (e.g. BEBA mixer - double-barreled)
4. Vacuum pump
5. Duct tape
6. BRAWO® Impregnation system (electrical or manual)
7. BRAWO® Inversion drum (compressed air) ***or*** BRAWO® Tripod (water column)
8. Retraining strap and circulation CIPP
9. Climatic cabinet for temperature control of the resin
10. BRAWO® curing device (for use with hot curing resins, e.g. BRAWO® TC)

Optionally required:

1. Preliner
2. Calibration CIPP
3. BRAWO® Resin Mixing Unit
4. Connection collars
5. BRAWO® curing device (e.g. HotBox, SteamBox, SteamUnit) incl. accessories
6. BRAWO® VortexCutter
7. Milling robot (e.g. IMS Micro)
8. 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 methods

Curing the resin is done by a chemical reaction of the components A and B and begins with the mixing. An influence on the time period of the curing process can be made by the temperature of the resin. For more detail, refer to ***section 7.0.0 "Things to know about reaction resins"*** on ***page 94***.

There are three curing methods to select from:

1. **Curing at ambient temperature ("cold curing")**

   During **curing at ambient temperature** the inversed **BRAWOLINER®** remains pressurized with pressure until the curing is complete. No additional heat is applied.

2. **Hot curing (water) (in accordance with Quality Seal S27.1)**

   During hot curing (water) the BRAWO® HotBox hot water heating system is used. With this the liner is filled completely with water, the water is circulated and heated by the BRAWO® HotBox by means of a circulation pump. The curing period is significantly shortened by the applied heat.

3. **Steam curing (in accordance with Quality Seal S27.2)**

   During steam curing the BRAWO® SteamUnit is used. The use is recommended only when using **BRAWOLINER®** with additional calibration CIPP or **BRAWOLINER®** HT. A steam-air mixture streams through the inversed liner. This curing method is used when the height difference between the start and end of the line exceeds 4 meters, and the use of water as heat carrier is no longer possible.

A guide to hot water and steam curing can be found in the ***section 4.10.0 "Hot curing"*** starting on ***page 76*** and in the ***section 4.11.0 "Hot curing (steam)"*** starting on ***page 84***.

4.0.0 Installation process - Guidelines

The these process instructions the **BRAWOLINER®** process for the **house connection rehabilitation** (**BRAWOLINER®** system) and for **Inhouse Rehabilitation (BRAWOLINER® HT** System) is discussed.

The installation of the **BRAWOLINER®** is identical for both systems.

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.**
- **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 25 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. We recommend documenting the rehabilitation. For this, also refer to *section 8.0.0 "Installation protocol"* on *page 100.***

4.1.0 Preparation of the line to be rehabilitated

NOTE!

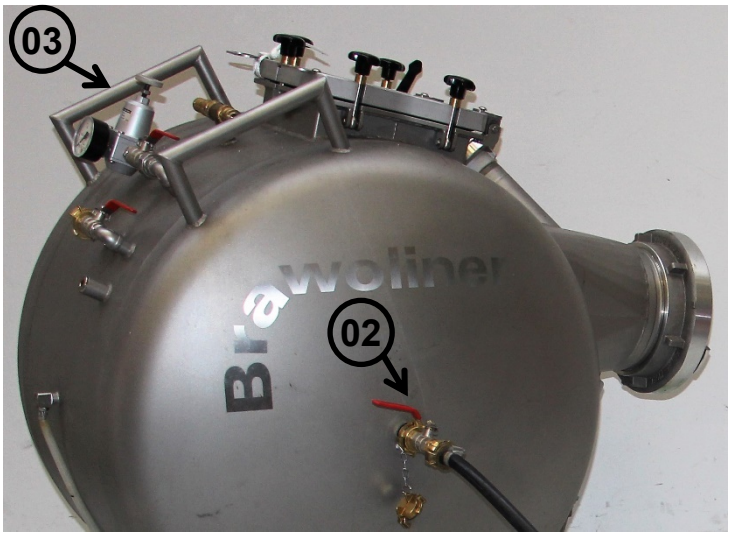
The foundation must be clean and free of all loose parts, dust, oil, grease or other substances that could have a negative effect on adhesion.
It can be dry or damp The foundation must be capable of carrying the load and have a generally required tear strength of min. 1.5 N/mm².

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 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 4.3.0 "Inverting the preliner"*** on ***page 35***.
7. Make sure that during the rehabilitation that no waste water is introduced. Block storm water inlet, if necessary.

4.2.0 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. If a hot curing (water) is intended, remove the side cover cap (GEKA) and connect the ball valve pos. 02.
3. Make sure that all ball valves are closed.



4. Have the correct inversion pipe, inversion CIPP and Storz coupling wrench ready. For steam curing an inversion pipe with steam inlet or an intermediate piece with steam inlet must be provided. When releasing the opening the BRAWO® steam sleeve must be connected to maintain the interior pressure of the compressor (min. 1300 l/min) via the control unit on the steam inlet.
5. Rub the inversion pipe with detergent and pull in the retractable cable (for pulling though the liner later).
6. Check adequate length of the retaining strap and, for a planned hot curing (water), the length of the water CIPP and have these ready. Be sure to have an adequate length of the retaining cable and the water CIPP.
7. Dependent on curing method

BRAWO® Tripod

1. Bring the inversion equipment into position, ensure adequate water supply.

Further procedure, see Point 4.

7.1. Cold curing:
Fasten the retaining cable with one end on the drum reel and wind several layers around the axle or have ready for inversion with the BRAWO® Tripod.

7.2. Hot curing (water):
Fasten the start of the water CIPP in the drum on the GEKA connection on the drum axle. Fasten the retaining cable with one end on the drum reel and wind several layers around the axle, then wind parallel with the water CIPP on the drum axle or have ready for inversion with the BRAWO® Tripod. Make sure that the end of the water CIPP is fastened on the retaining strap.

7.3. Steam curing:
Fasten the retaining cable with one end on the drum reel and wind several layers around the axle.

8. Have ready the correct CIPP clamps, cable ties, duct tape and rechargeable screwdriver.
9. Prepare transport bath (cold water with some detergent)
10. Ensure power supply.
11. Prepare BRAWO® resin mixing system or have ready Beba mixer.
12. Prepare BRAWO® impregnation system.
13. Make BRAWO® SteamUnit or BRAWO® HotBox ready for operation.
14. Check the functionality of the installation equipment.

4.3.0 Inverting the preliner

4.3.1 Inversion of the preliner with BRAWO® inversion drum

CAUTION!

DANGER OF CRUSHING!
Wear protective 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

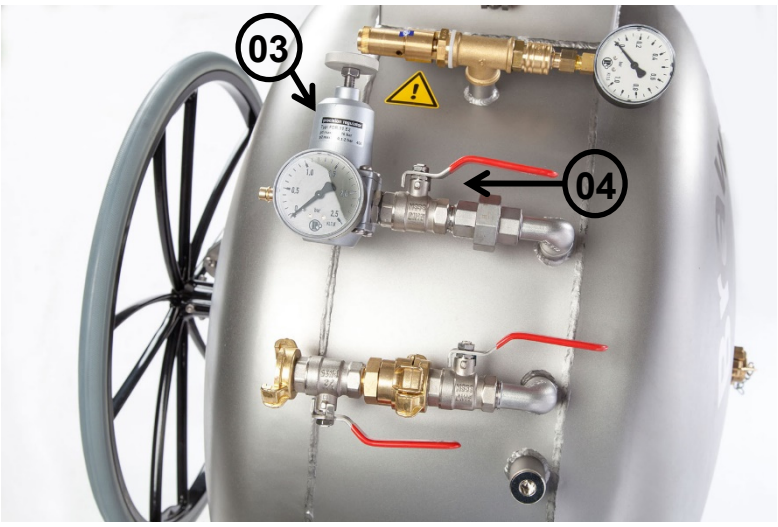
1. Wind up the preliner with the open end on the drum axle. Do not connect the end of the preliner with the retaining strap!

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 (***see* CAUTION!** on ***page 7***).



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 ball valve (Pos. 04).

9. Open the CIPP clamps on the inversion pipe and fasten the preliner on the shaft.

4.3.2 Inversion of a preliner with BRAWO® Tripod

DANGER!

- **RISK OF TIPPING!**
  Always ensure a secure positioning of the BRAWO® Tripod.
- **RISK OF FALLING when working on scaffolding and ladders**

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

Rehabilitation length + addition for fastening on the inversion pipe

1. 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 and the corresponding inversion pipe.
3. Invert the beginning of the preliner and fasten on the inversion pipe 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 first operator begins filling the inversion CIPP with water. Normally inversion is done with a water column of approx. 2-3 m (≈ 0.2–0.3 bar).
6. The inversion speed can be influenced by the quantity of the supplied water.
7. The inversion is completed when the preliner has reached the end of the rehabilitation section and opens. The water escapes and the preliner collapses.
8. Open the CIPP clamps on the inversion pipe and fasten the preliner on the shaft.

NOTE!

Installation must only be done in the direction of flow!

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

ATTENTION!

Only required if the installation variant "open end" or "open end with BRAWO® steam sleeve" is 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 (15 cm when using the BRAWO® steam sleeve) for connecting the calibration CIPP**
+	**approx. 60 cm for safety reasons**
=	**Length of the calibration CIPP**

NOTE!

The calibration CIPP must always be somewhat longer that 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!

1. Cut the calibration CIPP to length.
2. Connect the calibration CIPP end (depending on curing method)

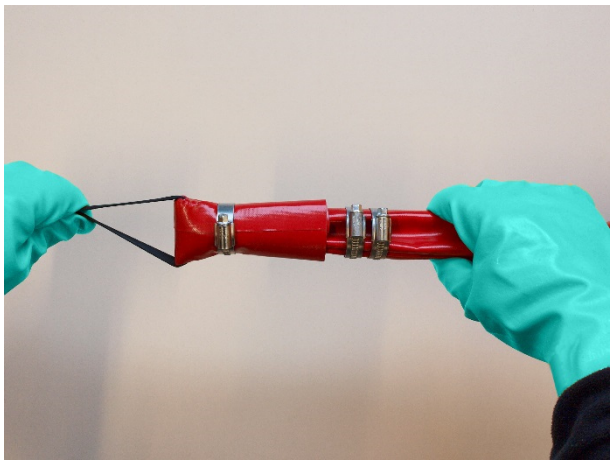
2.1. Curing with ambient temperature or hot curing (water) (variant "open end BRAWOLINER®")

Connect the end of the calibration CIPP air-tight and pressure tight.

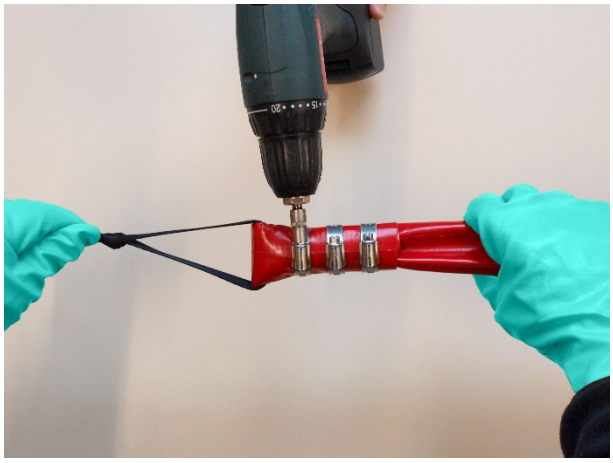
1. Fold the end of the calibration CIPP lengthwise.

2. Catch the folded piece with at least three loose CIPP clamps. Connect the retaining strap and calibration CIPP with each other via loops.

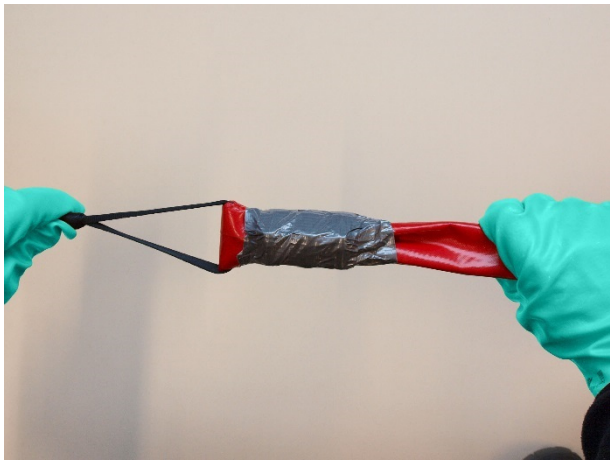
3. Pull the CIPP clamps over the folded part of the calibration CIPP.



4. Tighten the CIPP clamps evenly and tightly.



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

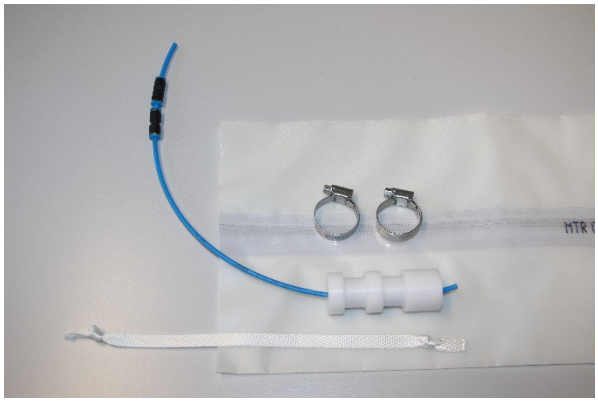


Wind the closed calibration CIPP connected with the retaining strap on the drum axle using the retaining strap. Fix the beginning of the calibration CIPP on the drum axle with adhesive tape. The **BRAWOLINER®** is then wound over it. Have the calibration CIPP ready for inversion using BRAWO® Tripod.

2.2. Steam curing (variant “open end BRAWOLINER® / BRAWO® Steam sleeve in the calibration CIPP”)

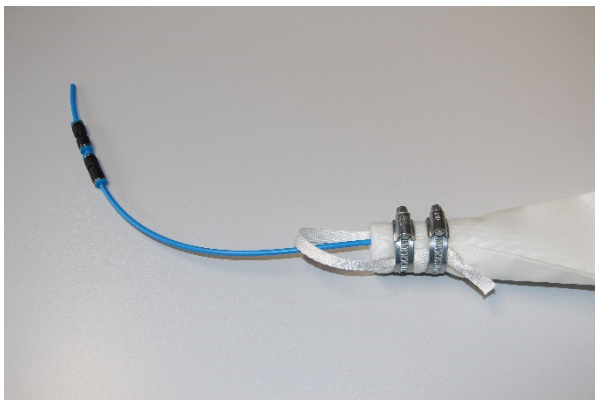
Fasten the BRAWO® Steam sleeve in the end of the calibration CIPP. Make sure that the condensate CIPP is on the outside.

1. Knot the retaining strap on the end and have ready.

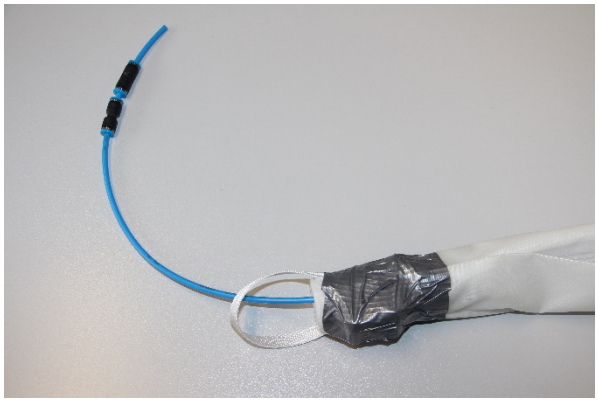


2. Place the BRAWO® Steam sleeve in the calibration CIPP and fold this around it in an S-shape.

3. Contain the folded piece with the CIPP clamps and bind with the retaining strap. Make sure that the CIPP clamps lie in the grooves of the BRAWO® Steam sleeve.



4. Tighten the CIPP clamps evenly and tightly and cut off as short as possible. To prevent damage, tape over the CIPP clamps.



ATTENTION!

It must absolutely be ensured that neither the calibration CIPP nor adhesive strip nor the end of the retaining strap extends past the sleeve. A protrusion > 1 mm must be cut off flush with the end of the sleeve, since otherwise the hole in the sleeve could be closed.

Wind the closed calibration CIPP connected with the retaining strap on the drum axle using the retaining strap. Fix the beginning of the calibration CIPP on the drum axle with duct tape. The **BRAWOLINER®** is then wound over it.

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

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

“Open End” (cold water, hot water or steam curing):

	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®**

“Closed End” (cold water, hot water or steam curing):

	Rehabilitation length
+	**Addition for fastening on the inversion pipe**
+	**approx. 40 cm for connection (alternatively 15 cm for integrating the BRAWO® Steam sleeve)**
=	**Length of the BRAWOLINER®**

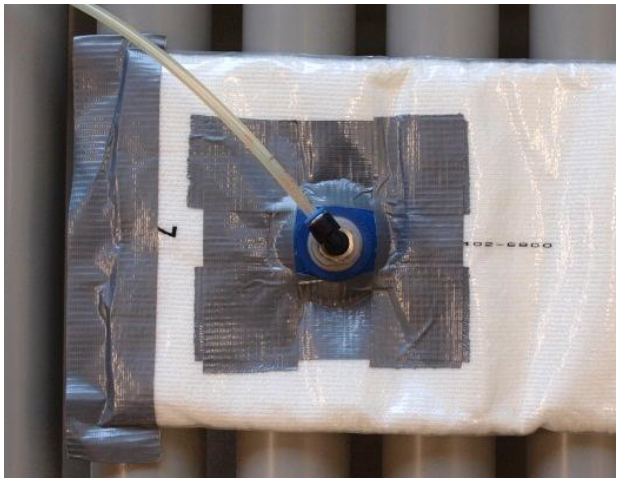
NOTE!

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.

5. Close the end of the **BRAWOLINER®** airtight with duct 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 duct tape and suck the air out of the **BRAWOLINER®** with approx. 500 mbar vacuum.



4.6.0 Impregnating the BRAWOLINER®

DANGER! **Epoxy resin**

GHS 05

GHS 07

GHS 08

GHS 09

- *Causes serious chemical burns of the skin and severe eye damage.*
- *Causes skin irritation.*
- *Can damage the organs in case of extended or repeated exposure.*
- *Causes severe eye irritation.*
- *Hazardous to health if swallowed.*
- *Can presumably impair fertility. Can presumably cause harm to the unborn child.*
- *Toxic to water organisms with long-term effects*

⇨ **Wear protective gloves/eye protection/ face shield.**

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

⇨ **Avoid inhalation of dust/smoke/gas/fog/vapor/aerosol.**

⇨ **Avoid releasing in the environment.**

⇨ **Ensure good ventilation during the mixing process.**

⇨ **Follow current safety data sheets.**

ATTENTION!





CAUSTIC EFFECT / RISK TO HEALTH!

- **Face protection**
- **Or tightly sealed safety glasses**
- **Protective clothing,**
  e.g. chemical resistant protective suit
- **Chemical-resistant protective gloves tested acc. to EN 374, e.g. made of nitrile rubber.**
- **Wear filter mask type A, based on the danger and risk of an exposure.**
- **Observe current safety datasheet.**

ATTENTION!

The reaction of the resin begins with mixing the resin components. Quick work is required.

1. Calculate the required quantity of resin. Refer to ***section 7.5.0 “Resin”*** on ***page 98***.

2. Mix the determined quantity of components A and B taking into consideration the ***section 7.3.0 "Processing instructions"*** on ***page 95***.

3. Fill the resin in the **BRAWOLINER®**.

4. Fold back the cuff again on the fill end to prevent possible leakage of resin.

5. Distribute and work in the resin with the BRAWO® impregnation system. Select and set the roller distances corresponding to the ***section 7.5.0 "Resin*** consumption BRAWOLINER®*"* on ***page 98***. Normally one to two rolling passes are necessary to impregnate the **BRAWOLINER®** evenly.

6. Check the length of the **BRAWOLINER®** if necessary.

7. The impregnated **BRAWOLINER®** is brought to the BRAWO® inversion drum on the transport belt.

4.7.0 Close the BRAWOLINER® end

4.7.1 Closed end 50-70

Especially with the installation of the BRAWOLINER® DN 50 and DN 70 make sure of the most narrow and bendable liner end.

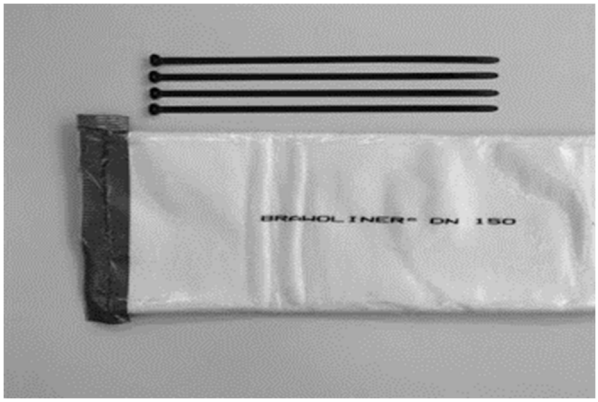
1. Connect the **BRAWOLINER®** airtight with duct tape, know the end of the retaining strap and place on the**BRAWOLINER®**.

2. Fold the **BRAWOLINER®** around the retaining strap. Protect the **BRAWOLINER®** in front and behind the placed knots from damage with duct tape. Connect the **BRAWOLINER®** tightly on the adhesive strips each with a cable tie, so that the knots cannot slide out.

3. To prevent damage, tape over the cable ties.

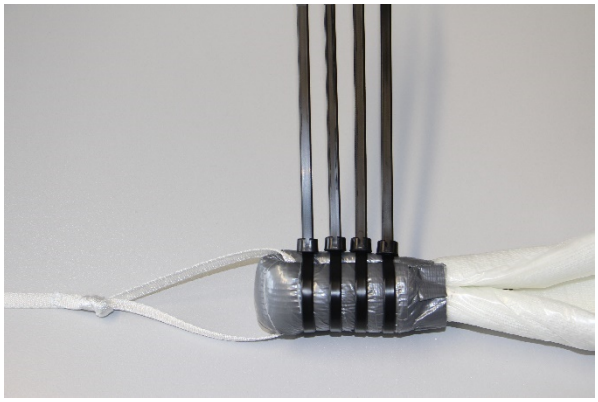
4.7.2 Closed end 100-200

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

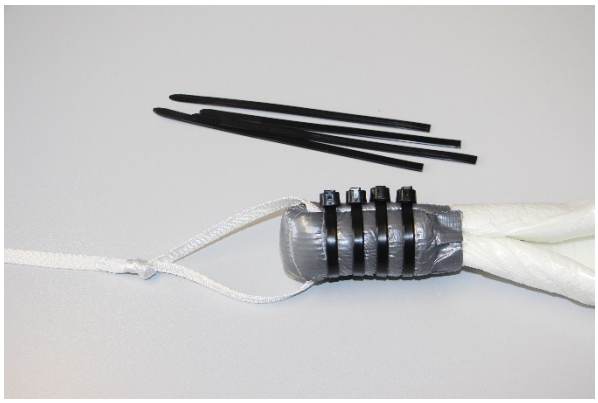


2. Fold the **BRAWOLINER®** lengthwise and wrap with duct tape.

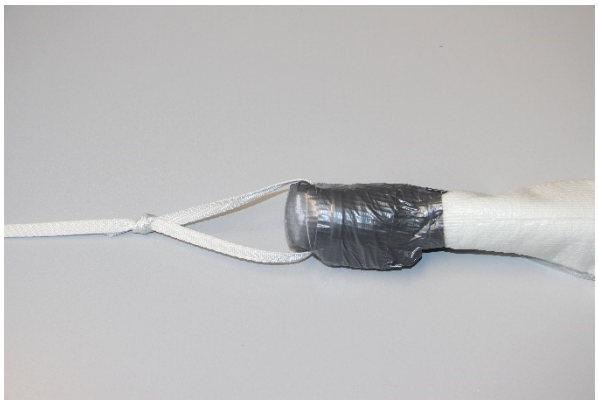
3. Connect the retaining strap and **BRAWOLINER®** with each other via loops. Close the loops tight with cable ties.



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

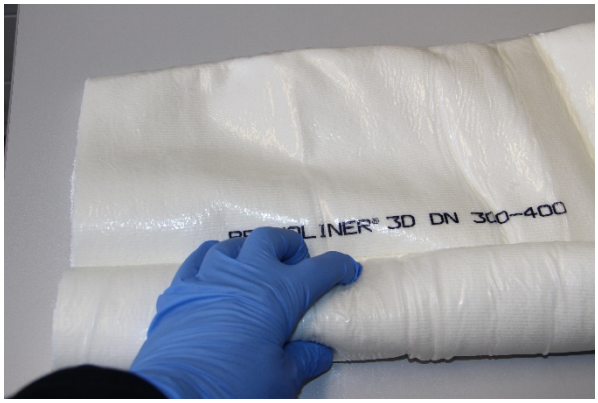


5. Completed knots



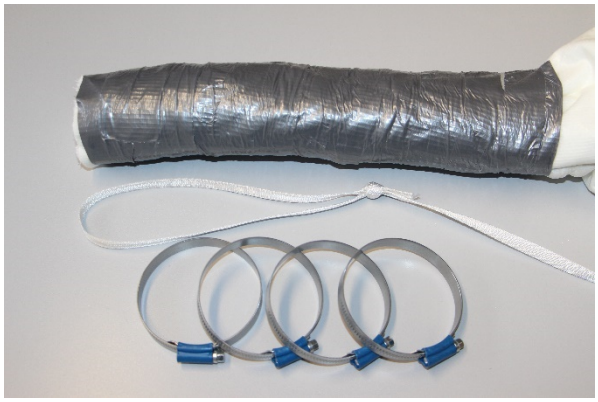
4.7.3 Closed end DN 200-300, DN 300-400

1. Fold the **BRAWOLINER®** lengthwise in half in one direction.

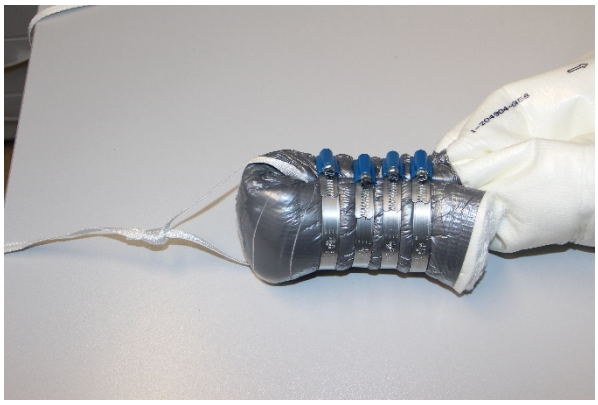


2. Fold the other side of the **BRAWOLINER®** so that an “S” results.

3. Fix the “S” with duct tape and then wrap a piece approx. 37 cm long tightly with duct tape.



4. Place a loop (for later connection with the retaining strap) in the **BRAWOLINER®** and connect tightly with CIPP clamps.



5. To prevent damage, tape over the CIPP clamps with duct tape until no sharp edges are noticed.

4.7.4 Open end

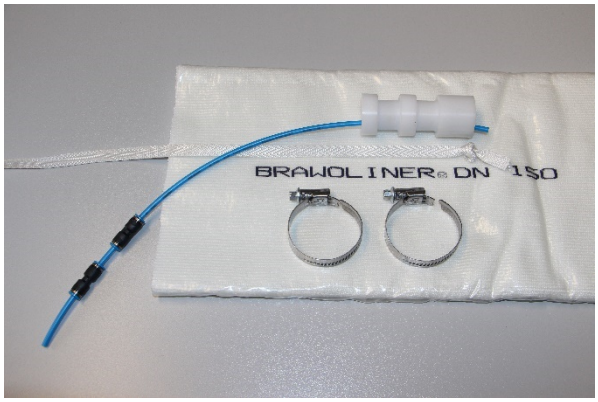
1. Cut of the end of the **BRAWOLINER®** at the marking of the linear length (rehabilitation length + addition for fastening on the inversion pipe). Pay attention that the liner is completely saturated with resin until over the marking.

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!

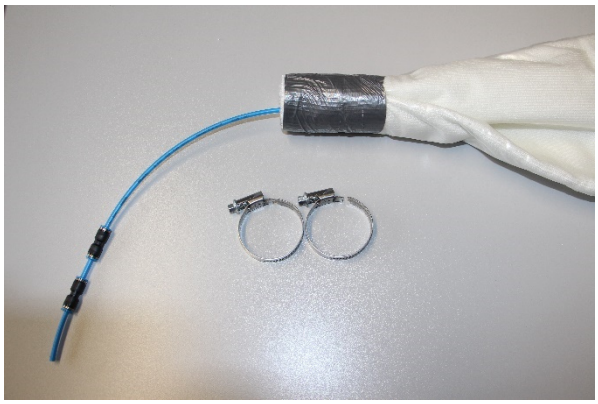
4.7.5 BRAWO® Steam sleeve in the BRAWOLINER® DN 50-70 and DN 100-250

1. Knot the retaining strap on the end and have ready.

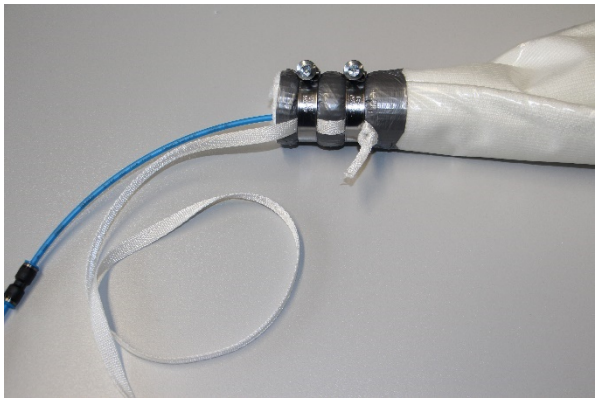


2. Place the correct BRAWO® Steam sleeve in the **BRAWOLINER®** and fold this around it in an S-shape.

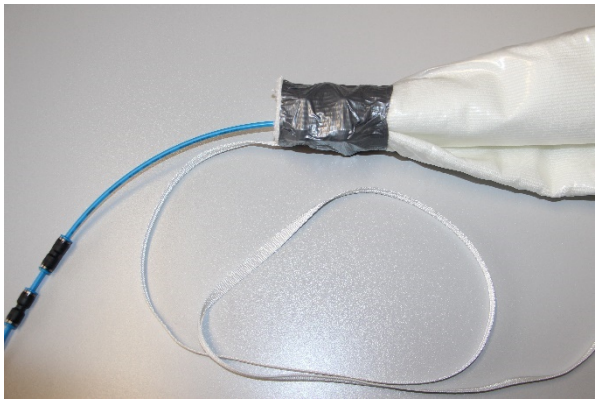
3. Wrap the folded piece with adhesive tape.



4. Contain the folded piece with the CIPP clamps and bind with the retaining strap. Make sure that the CIPP clamps lie in the grooves of the BRAWO® Steam sleeve. Tighten the CIPP clamps evenly and tightly.



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



ATTENTION!

It must absolutely be ensured that neither the liner, duct tape nor the end of the retaining strap extends past the sleeve. A protrusion > 1 mm must be cut off flush with the end of the sleeve, since otherwise the hole in the sleeve could be closed.

NOTE!

Fastening the retaining strap should be done up to DN 70 with cable ties, for nominal diameter > DN 100 with CIPP clamps.

4.8.0 Inverting the BRAWOLINER®

For the inversion of the **BRAWOLINER®** there are basically two methods to choose from:

1. **Inversion method with BRAWO® Inversion drum**
2. **Inversion method BRAWO® Tripod**

Both methods are divided into possible variants:

a) Installation with closed end
b) Installation with open end
c) Installation with BRAWO® Steam sleeve in the **BRAWOLINER®** (only for inversion process with BRAWO® Inversion drum and subsequent steam curing)

For acceleration of the curing process, an optional **hot curing (water)** can be done at the end with variants a) and b).
An accelerated **curing with steam** can be done with the use of the BRAWO® Inversion drum and the use of the BRAWO® Steam sleeve in the ends.

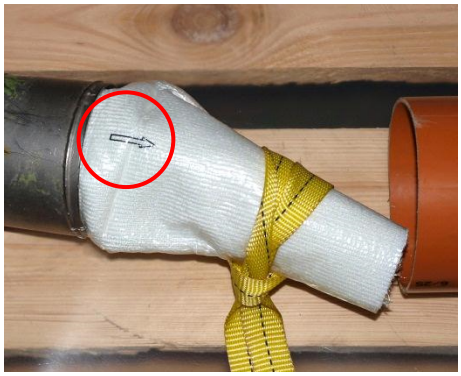
4.8.1 Inversion of the BRAWOLINER® with BRAWO® inversion drum

CAUTION!

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

ATTENTION!

- **Spray the impregnated BRAWOLINER® again with a lubricant (e.g. detergent, vegetable oil, or similar), while bringing in the BRAWO® Inversion drum. This increases the gliding properties of the BRAWOLINER® during the inversion.**
- **Direction of installation: The arrow imprinted on the liner must always point in the direction of the rehabilitation start (beginning of pipe).**



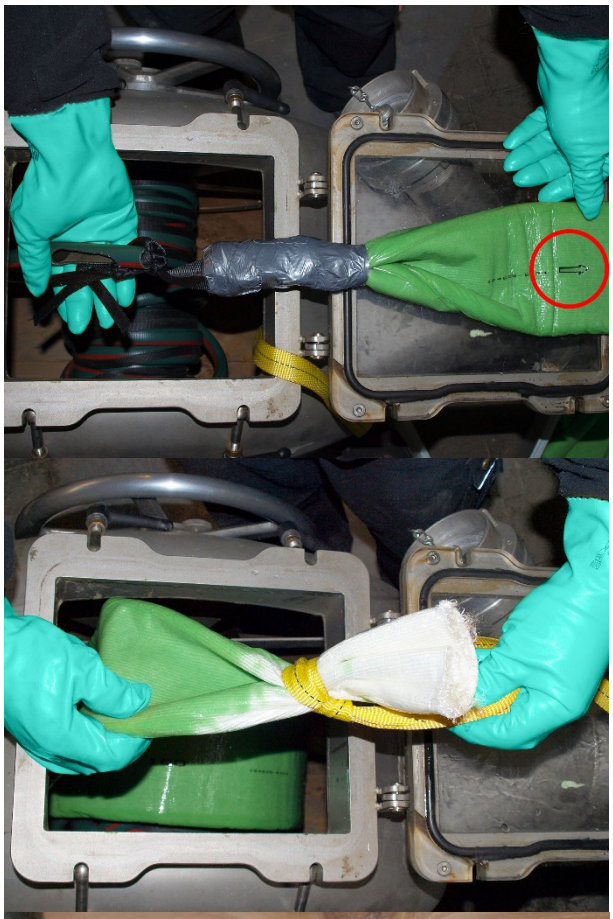
- **Especially during installation of the BRAWOLINER® 3D with open end, the PU film must be provided with sufficient lubricant. This prevents a "blocking" of the calibration CIPP, e.g. at dimensional offsets.**

ATTENTION!

- **The retaining strap, possibly CIPPs and calibration CIPP must already be in the BRAWO® inversion drum before winding up the BRAWOLINER®!**
- **When using the BRAWO® Steam sleeve in the liner end make sure that the air supply quantity of the compressor is greater than the escaping air quantity!**
- **The hole in the BRAWO® Steam sleeve can be adjusted with sufficiently available air quantity.**
- **The installation recommendations for inversion pressures on page 25 must be followed.**
- **Especially the BRAWOLINER® 3D DN 200-300 and the BRAWOLINER® 3D DN 300-400 must be supported outside of the pipe during installation with closed end:**
  - **between inversion bend and beginning of the pipe**
  - **at the pipe end**

  e.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.



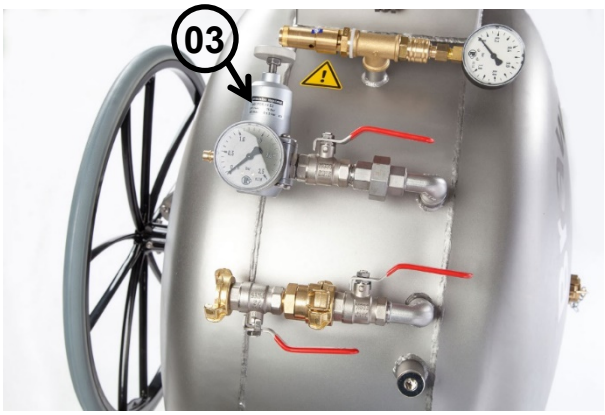
2. Push through the beginning of the **BRAWOLINER®** with the aid of the retractable cable through the inversion nozzles and the corresponding inversion pipe.

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

4. Protect the cuff from damage with duct 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).

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 page 31 and page 25***).



7. The inversion speed can be impacted on the pressure control valve (Pos. 03) and on the handwheel of the BRAWO® inversion drum.

8. Installation variant dependent:

8.1. Variant “open end”

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. For further working methods see the ***section 4.9.1 “Inversion of the calibration CIPP with BRAWO® inversion drum”*** starting on ***page 69***.

8.2. Variant “closed end”

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 until complete curing. It must be oriented as much as possible on the curing pressure recommended per liner type (**see page 25**). Special conditions on site can require deviating pressures (***see page 31***).

The further procedure depends on the variant:

- **Curing at ambient temperature**

  Pay attention to the information for curing times at ambient temperature. For this refer to the ***section 3.3.4 “Resin types”*** on ***page 22*** or the technical data sheets of the BRAWO® resins.
  Further working procedure is described starting with Point 9. on ***page 64***.

- **Hot curing (water)**

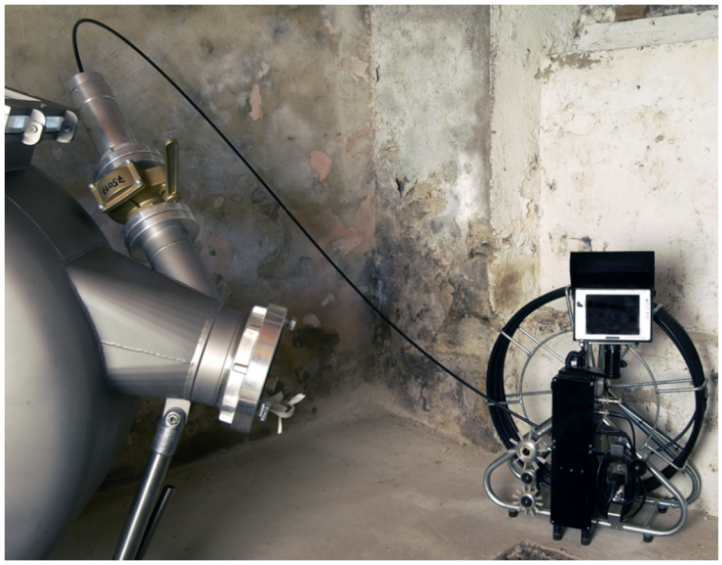
  Refer to ***section 4.10.0 “Hot curing (water)”*** starting on ***page 76***.

8.3. Variant "BRAWO® steam sleeve in the BRAWOLINER®"

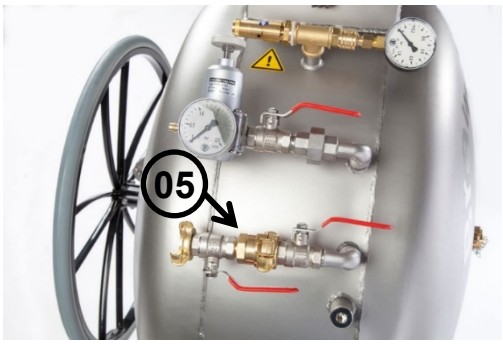
When reaching the end of the rehabilitation section, the **BRAWOLINER®** releases the openings in the BRAWO® Steam sleeve. Decreasing the interior pressure must be counteracted by increasing the air supply quantity on the pressure control valve of the control unit.

For more detail refer to the ***section 4.11.0 "Hot curing (steam)"*** starting on ***page 84***.

9. The rehabilitation section can be controlled under pressure using an inspection camera.

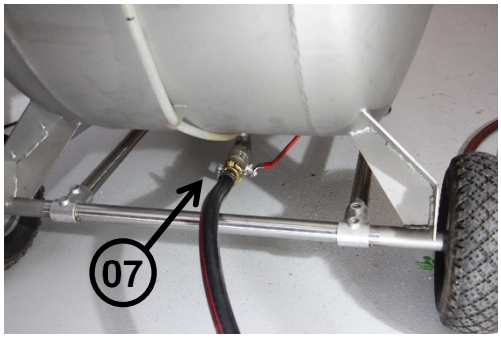


10. After the complete curing, release the system pressure (open ball valve Pos. 05).



11. Open the CIPP clamps on the inversion pipe.
12. Cut the **BRAWOLINER®** flush with the old pipe. Equalize unevenness in the bottom area if necessary (e.g. with cement mortar).

    If there is water in the drum, open the ball valve pos. 07 and drain it.



13. If necessary open closed supply lines with a suitable tool.

– The installation variant selected is completed. –

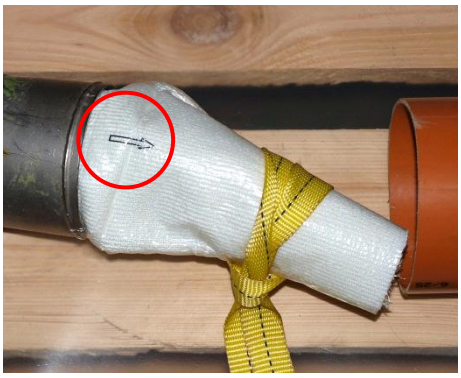
4.8.2 Inversion of the BRAWOLINER® with BRAWO® Tripod

DANGER!

- **RISK OF SCALDING from hot water**
- **RISK OF TIPPING!**
  Always ensure a secure positioning / fastening of the equipment.
- **RISK OF FALLING when working on scaffolding and ladders.**

ATTENTION!

- **Direction of installation: The arrow imprinted on the liner must always point in the direction of the rehabilitation start (beginning of pipe)!**



- **The inversion pressure should be set according to liner type from the table on page 25.**

.

1. **For hot curing (water) observe:**

   For the "closed end" variant a sufficiently longer water CIPP is connected with the closed end of the impregnated **BRAWOLINER®** (parallel to the retaining strap).

   For the "open end" variant the water CIPP is connected and inversed with the calibration CIPP.

   A steam curing is not recommended in combination with the DRAWO® Tripod.

2. Push through the beginning of the **BRAWOLINER®** with the aid of the retractable cable through the inversion CIPP and the corresponding inversion pipe.

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

4. Protect the cuff from damage with duct 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).

6. The 2nd operator gives the signal to start. Then the first operator begins filling the inversion CIPP with water. Normally inversion is done with a water column of 2-3 m (≙ 0.2–0.3 bar). Please observe the recommendations for each liner type from **page 25**. Special conditions on site can require deviating pressures (***see ATTENTION!*** on ***page 31***).

7. The inversion speed can be influenced by the quantity of the supplied water and possibly on the retaining strap.

8. Variant dependent:

8.1. Variant “open end”

When the **BRAWOLINER®** is halfway inversed the end closed with the rubber glove must be released. 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. For further working methods see the ***section 4.9.2 “Inversion of the calibration CIPP with BRAWO® Tripod Inversion of the calibration CIPP with ”*** on ***page 73***.

8.2. Variant “closed end”

The inversion is completed when the **BRAWOLINER®** has reached the end of the rehabilitation section. Fasten the retaining strap on the inversion equipment. The **BRAWOLINER®** is cured with the recommended pressure of each liner type (**see page 25**). Normally curing is done with a water column of 3-4 m (≙ 0.3–0.4 bar). Special conditions on site can require deviating pressures (***see ATTENTION!*** on ***page 71***).

The further procedure depends on the variant:

- **Curing at ambient temperature:**

  Pay attention to the information for curing times at ambient temperature. For this refer to the ***section 3.3.4 "Resin types"*** on ***page 22*** or the technical data sheets of the BRAWO® resins.

  Further working procedure is described starting with Point 9. on ***page 68***.

- **Hot curing (water):**

  Refer to ***section 4.10.0 "Hot curing"*** starting on ***page 76***.

9. After complete curing drain or pump the water column.
10. Open the CIPP clamps on the inversion pipe.
11. Cut the **BRAWOLINER®** flush with the old pipe. Equalize unevenness in the bottom area if necessary (e.g. with cement mortar).
12. If necessary open closed supply lines with a suitable tool.

– The installation variant selected is completed. –

4.9.0 Inverting the calibration CIPP

For the inversion of the calibration CIPP there are basically two methods to choose from:

1. **Inversion method with BRAWO® Inversion drum**
2. **Inversion method with BRAWO® Tripod**

For acceleration of the curing process, both methods can be done with **hot curing (water)** at the end.

4.9.1 Inversion of the calibration CIPP with BRAWO® inversion drum

CAUTION!

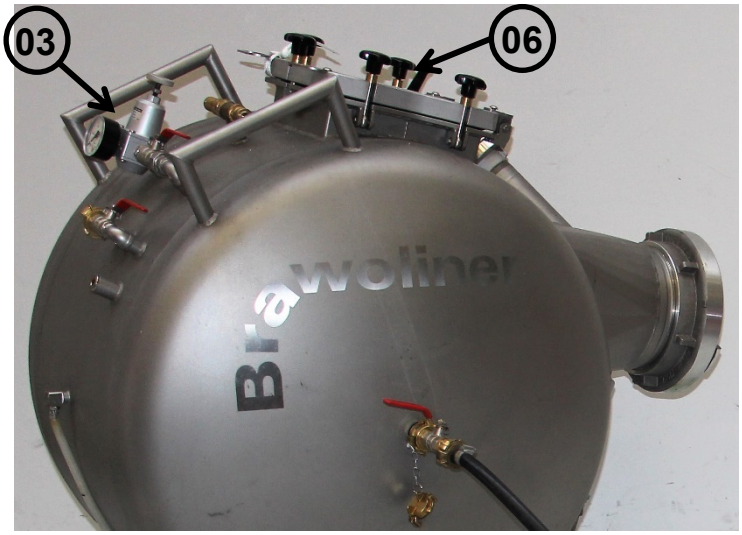
DANGER OF CRUSHING!
Wear protective protective gloves in the area of the handwheel.

ATTENTION!

- **Too early holding back of the calibration CIPP can reduce the water circulation during hot curing (water).**
- **The inversion pressure should be set according to the recommendations on page 25 and page 31.**
- **The technical data of the calibration CIPPs used must be observed.**
- **Especially for nominal diameters >DN 225 the curing pressure must be limited according to the specifications.**

1. After the rubber ring on the end of the inversion method “open end” has sprung off, the **BRAWOLINER®** collapses into itself.

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



3. Open the CIPP clamps on the inversion pipe, loosen the **BRAWOLINER®** and secure against slipping.

4. 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.

5. Fold over the beginning of the calibration CIPP on the inversion pipe, fix with duct tape and together with the already inverted **BRAWOLINER®** fasten with at least two cable clamps. Close the inspection glass (Pos. 06) airtight.

6. Align the inversion pipe to the pipe to be rehabilitated (2nd operator).

7. 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 31 and page 25***).

8. The inversion speed can be impacted on the pressure control valve (Pos. 03) and on the handwheel of the BRAWO® inversion drum.

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

ATTENTION!

- **Too early holding back of the calibration CIPP can reduce the water circulation during hot curing (water).**
- **The curing pressure should be set according to the recommendations on page 25 and page 31.**
- **The technical data of the calibration CIPPs used must be observed.**
- **Especially for nominal diameters >DN 225 the curing pressure must be limited according to the specifications.**

10. Lock the handwheel.

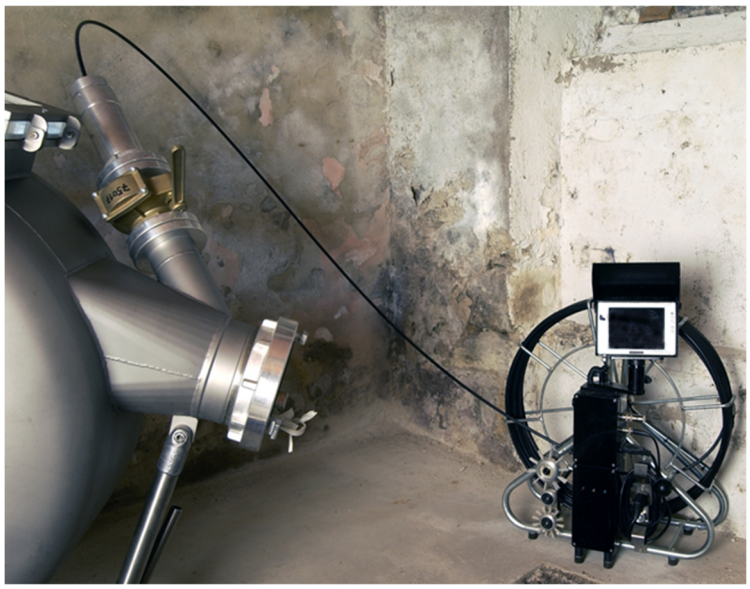
11. The pressure in the rehabilitation section must be maintained at 0.3 to 0.4 bar until the resin is cured. Special conditions on site can require deviating pressures (*see* **ATTENTION!** on *page 31*).
    The further procedure depends on the variant:

    - **Curing at ambient temperature**

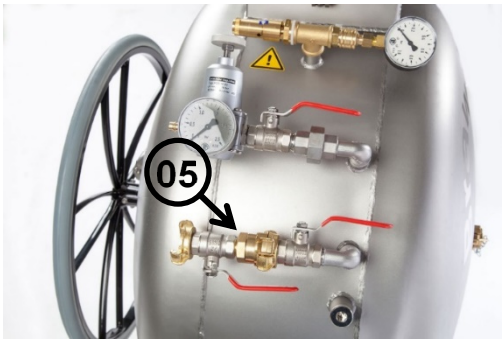
      Pay attention to the information for curing times at ambient temperature. For this refer to the *section 3.3.4 "Resin types"* on *page 22* or the technical data sheets of the BRAWO® resins.
      Further working procedure is described starting with Point 12 on *page 72*.
    - **Hot curing (water)**

      Refer to *section 4.10.0 "Hot curing"* on *page 76*.

12. The rehabilitation section can be controlled under pressure using an inspection camera.



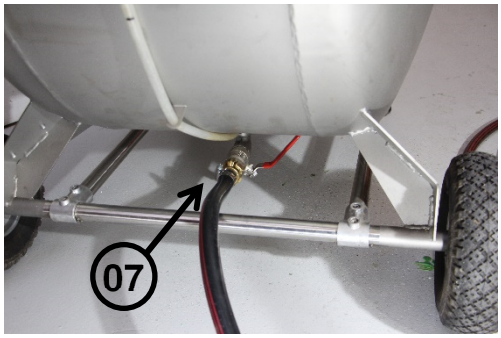
13. After the completed curing of pull out the calibration CIPP under low pressure (approx. 0.05 bar) with the aid of the retaining strap from the **BRAWOLINER®** by turning back.



14. Bleed the system pressure (open ball valve pos. 05).

15. Open the CIPP clamps on the inversion pipe. calibration CIPP.

16. Cut the **BRAWOLINER®** flush with the old pipe. Equalize unevenness in the bottom area if necessary (e.g. with cement mortar).



17. If there is water in the drum, open the ball valve pos. 07 and drain it.

18. If necessary open closed supply lines with a suitable tool.

– The installation variant selected is completed. –

4.9.2 Inversion of the calibration CIPP with BRAWO® Tripod

DANGER!

- **RISK OF SCALDING from hot water**
- **RISK OF TIPPING!**
  Always ensure a secure positioning / fastening of the equipment.
- **RISK OF FALLING when working on scaffolding and ladders**

ATTENTION!

If the liner type BRAWOLINER® 3D is inversed, the calibration CIPP must be well lubricated (also inside). Inverse the calibration CIPP slowly and with increased pressure (acc. to table page 25). The nominal diameter of the calibration CIPP must always correspond at least to the largest present pipe diameter.

- **The technical data of the calibration CIPPs used must be observed.**
- **Especially for nominal diameters >DN 225 the curing pressure must be limited according to the specifications.**

1. After the rubber ring on the end of the inversion method “open end” has sprung off, the **BRAWOLINER®** collapses into itself.

2. Open the CIPP clamps on the inversion pipe, loosen the BRAWOLINER® and secure against slipping.

3. Push the beginning of the calibration CIPP through the inversion CIPP and the inversion pipe.

4. Fold over the beginning of the calibration CIPP on the inversion pipe, fix with duct tape and together with the already inverted **BRAWOLINER®** fasten with at least two cable clamps.

5. Align the inversion pipe to the pipe to be rehabilitated (2nd operator).

6. The 2nd operator gives the signal to start. Then the first operator begins filling the inversion CIPP with water. Normally inversion is done with a water column of 2-3 m (≙ 0.2–0.3 bar). Special conditions on site can require deviating pressures (see ATTENTION! on page 31 and page 25).

7. The inversion speed can be influenced by the quantity of the supplied water and on the retaining strap.

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

ATTENTION!

- **Too early holding back of the calibration CIPP can reduce the water circulation during hot curing (water).**
- **The curing pressure should be set according to the recommendations on page 25.**
- **The technical data of the calibration CIPPs used must be observed.**
- **Especially for nominal diameters >DN 225 the curing pressure must be limited according to the specifications.**

9. Fasten the retaining strap on the inversion equipment.

10. The pressure in the rehabilitation section must be maintained at 3 – 4 m water column (≙ 0.3 – 0.4 bar) until the resin is cured. Special conditions on site can require deviating pressures (*see page 31*).

The further procedure depends on the variant:

- **Curing at ambient temperature**

  Pay attention to the information for curing times at ambient temperature. For this refer to the ***section 3.3.4 "Resin types"*** on ***page 22*** or the technical data sheets of the BRAWO® resins.

  Further working procedure is described starting with Point 11 on ***page 75***.

- **Hot curing (water)**

  Refer to ***section 4.10.0 "Hot curing (water)"*** starting on ***page 76***.

11. After the completed curing of pull the calibration CIPP under low pressure (approx. 0.5 m water column ≙ 0.05 bar) with the aid of the retaining strap out of the **BRAWOLINER®** by turning back. Pump out increasing water column if necessary.

12. Open the CIPP clamps on the inversion pipe and remove the calibration CIPP.

13. Cut the **BRAWOLINER®** flush with the old pipe. Equalize unevenness in the bottom area if necessary (e.g. with cement mortar).

14. If necessary open closed supply lines with a suitable tool.

– The installation variant selected is completed. –

4.10.0 Hot curing (water)

in combination with Quality Seal S27.1

DANGER!

- **RISK OF POISONING BY EXHAUST GASES!**
  Install the BRAWO® HotBox outside or ensure adequate removal of exhaust gases into the outside.
- **RISK OF FIRE!**
  Never cover the exhaust gas chimney (Pos. A).

WARNING!

RISK OF SCALDING
due to hot water or steam.

CAUTION!

RISK OF BURNS
on the BRAWO® HotBox. Parts can be hot.

ATTENTION!

The required preconditions for use of the BRAWO® HotBox must be observed. The separate operating and maintenance instructions of the BRAWO® HotBox must be followed.

NOTE!

The BRAWO® HotBox is an oil-fired heating module, that heats the water while circulating.

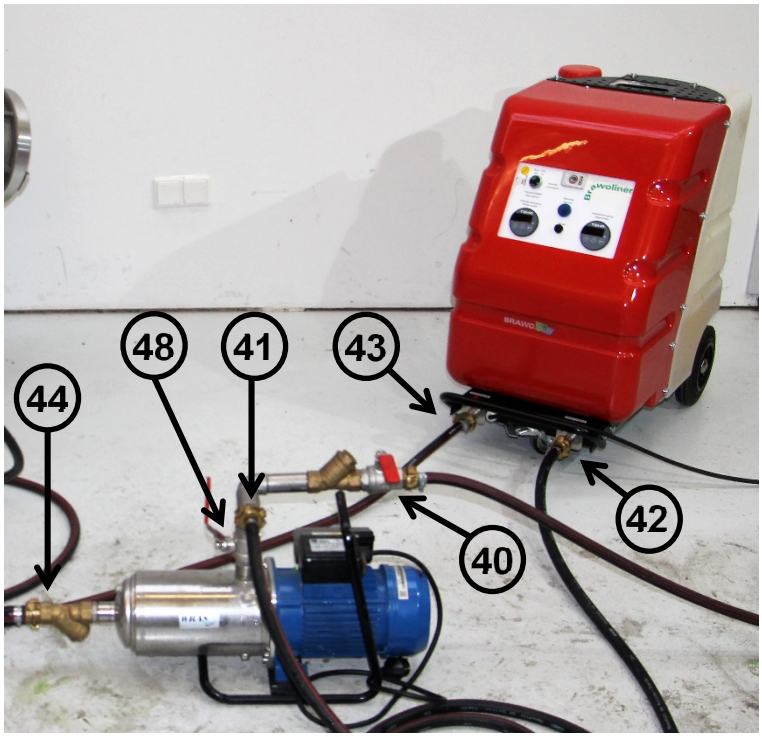
General preparations:

1. Connecting water supply:

   a) From water faucet to circulation pump (Pos. 40)

   b) From the circulation pump (Pos. 41) to water inlet of the BRAWO® HotBox (Pos. 42)

   c) From water outlet of the BRAWO® HotBox (Pos. 43) to the BRAWO® Inversion drum (Pos. 02), or the BRAWO® Tripod (=***forward flow***).



2. Connect the suction CIPP with the suction connection (Pos. 44) of the circulation pump. Here use the shortest CIPP possible. The other end of the suction CIPP must be connected with the ball valve on the bottom of the drum (Pos. 07), or with the BRAWO® Tripod the end of the suction CIPP protrudes sufficiently far into the BRAWO® Tripod and must be fastened (= ***reverse flow***).

3. The further procedure depends on the variant:

- **Variant BRAWO® Inversion drum**

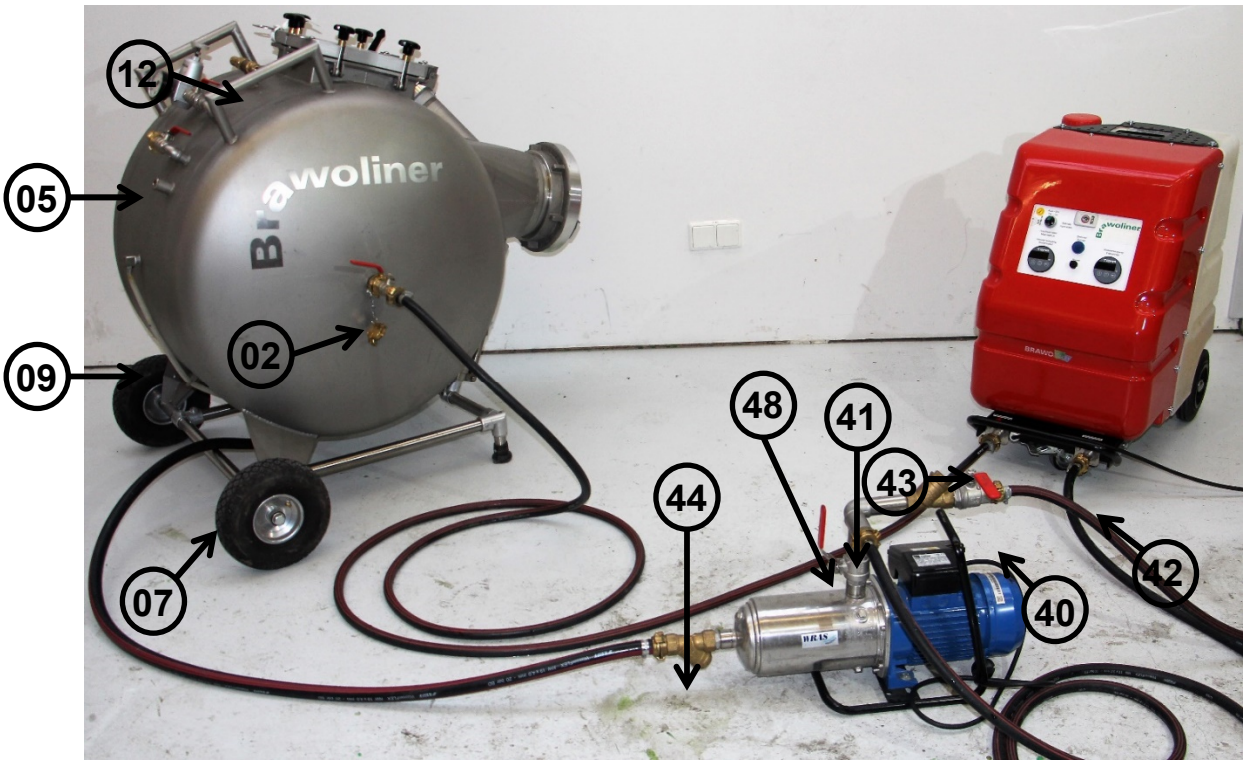
  Further working procedure is described starting with Point 4. on ***page 78***.

- **Variant BRAWO® Tripod**

  Make sure that the desired filling height for curing has been reached (normally 3 – 4 m). Close the ball valve (Pos. 40).

  Further working procedure is described starting with Point 7 on ***page 78***.

4. Filling water: Close the ball valve (Pos. 48), open the ball valve (Pos. 02), open the water faucet and the ball valve (Pos. 40) and let cold water run in until the BRAWO® Inversion drum is approximately one quarter full (water level indicator Pos. 09). During filling the system pressure must be continuously monitored (Pos. 12). With an increase over 0.4 bar release some air (ball valve Pos. 05). The operating pressure should be between 0.3 - 0.4 bar. Observe the varying curing pressure depending on liner type (**page 25**). Conditions on site can require deviating pressures (***see* ATTENTION!** on ***page 31***).



5. When the fill level has been reached, the ball valve Pos. 40 is closed.

6. Open the ball valve on the bottom of the drum (Pos. 07).

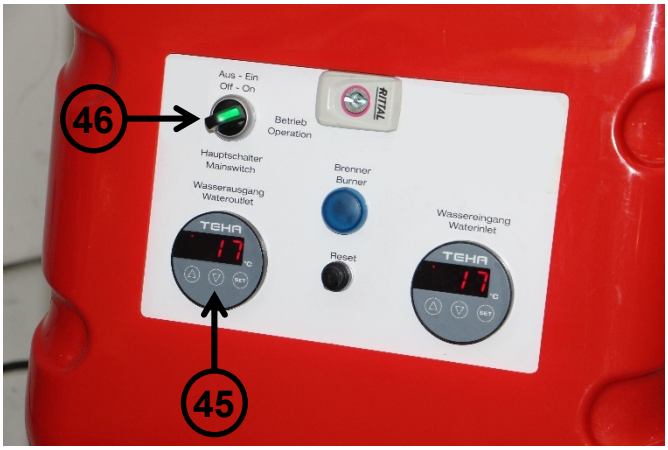
7. Open the ball valve for circulation (Pos. 48).

8. Make sure that no air is in the circuit, bleed if necessary. Finally turn on the circulation pump.

9. Turn on the BRAWO® HotBox (Pos. 46).

10. Set the recommended water temperature on the regulator of the BRAWO® HotBox (Pos. 45).

    - **Up to 55 °C:** **with use of BRAWOLINER®**
    - **Up to 75 °C:** **with use of BRAWOLINER® HT and/or temperature stable calibration CIPP**



11. The system pressure again increases during heating up. If necessary bleed air or water. The curing pressure should be between 0.3 - 0.4 bar (≙ 3 – 4 m water column). Conditions on site can require deviating pressures (***see* ATTENTION!** on ***page 14***). Also ***Section 2.4.0 "Sources of danger – Accident prevention"*** on ***page 7*** and the various installation instructions of the liner types used on ***page 60***, ***page 25*** and ***page 71***) must be observed.

12. The return temperature must be controlled (e.g. separate thermometer). After the return has reached the recommended temperature, the curing time begins.
    The required **total heating period** is made up as follows:

	Heat up time
+	**Curing time**
=	**Total heating period**

NOTE!

The burner turns on when:

- **The BRAWO® HotBox is turned on**
- **Water circulates**
- **The water temperature is below the set point temperature**

NOTE!

Observe the data for the curing time of the BRAWO® resins during hot curing.
For this refer to the *section 3.3.4 "Resin types"* on *page 22* or the technical data sheets of the BRAWO® resins.

ATTENTION!

CURING TIME:
Only after the return has reached the recommended temperature (=heat up time), does the curing time begin.

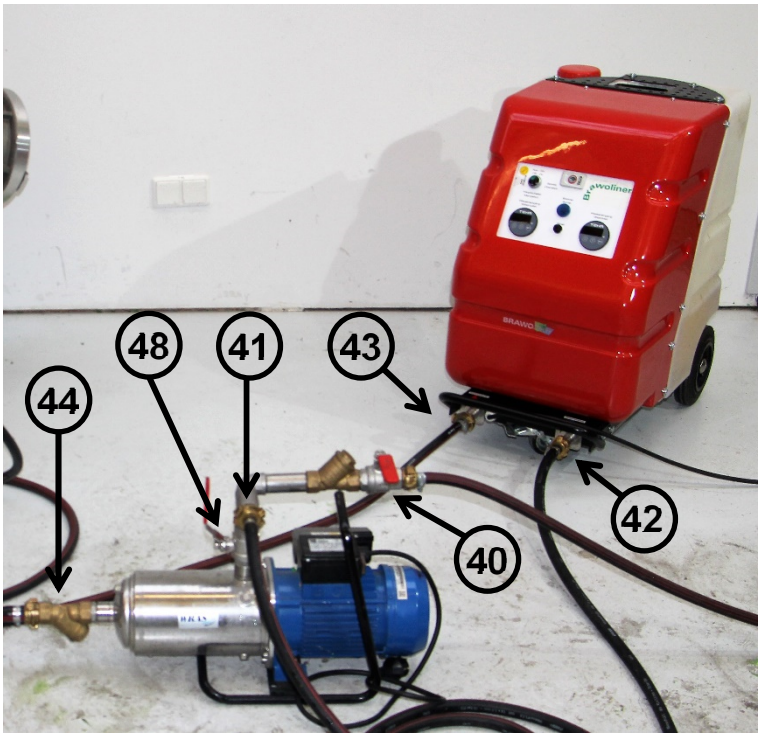
- **BRAWO® I: approx. 100 minutes at 50 °C**
  approx. 45 minutes at 70 °C
- **BRAWO® III/ AC: approx. 220 minutes at 50 °C**
  approx. 140 minutes at 70 °C
- **BRAWO® HT: approx. 140 minutes at 50 °C**
  approx. 80 minutes at 70 °C
- **BRAWO® TC: approx. 540 minutes at 60 °C**
  approx. 300 minutes at 70 °C

13. After the curing time has elapsed, check the strength of the inversed **BRAWOLINER®** (on the piece that protrudes out of the rehabilitated pipe). When the **BRAWOLINER®** can no longer be shaped by hand, the curing process is completed and the cooling process can be started.

ATTENTION!

Maintain constant pressure during cooling off.

14. Turn the BRAWO® HotBox off.



15. Remove the water CIPP from the water faucet at Pos. 40 and connect with the forward flow CIPP (was connected to the water outlet of the BRAWO® HotBox (Pos. 43).

16. Replace the return CIPP:

- **Variant BRAWO® Inversion drum**

  Place a water CIPP from the valve in the bottom of the drum (Pos. 07) outside (CAUTION: Do not direct water on the installed liner).

- **Variant BRAWO® Tripod**

  Remove the return CIPP on Pos. 42, extend if necessary and place outside (CAUTION: Do not direct water on the installed liner).

17. Open the water faucet and supply cold water until the inversion pipe is cold. The pressure must be held constant here:

    - **Variant BRAWO® Inversion drum**

      Regulate by opening the valve in the bottom of the drum (Pos. 07).

    - **Variant BRAWO® Tripod**

      Pump off the increasing water column.

18. Afterward close the water supply.

19. Drain system pressure:

    - **Variant “Closed end” BRAWOLINER®**

      If necessary open ball valve pos. 05.

      Open the **BRAWOLINER®** at the end of the rehabilitation section, the water flows out. Loosen the water CIPP and pull back.

    - **Variant "open end" BRAWOLINER®**

        - **Variant BRAWO® Inversion drum**

          a) Remove the water CIPP on the drum axle (Pos. 02).

          b) Open the inspection window (Pos. 06).

          c) Pull back the calibration CIPP and the water CIPP with the aid of the handwheel.

        - **Variant BRAWO® Tripod**

          a) Pump off the water column to ≤ 0.5 m.

          b) After the completed curing of pull the calibration CIPP under low pressure (approx. 0.5 m water column ≙ 0.05 bar) with the aid of the retaining strap out of the **BRAWOLINER®** by turning back. Pump out increasing water column if necessary.

20. Open the CIPP clamps on the inversion pipe.

21. Cut the **BRAWOLINER®** flush with the old pipe. Equalize unevenness in the bottom area if necessary (e.g. with cement mortar).

22. If there is water in the drum, open the ball valve pos. 07 and drain it.

23. If necessary open closed supply lines with a suitable tool.

– The installation variant selected is completed. –

4.11.0 Hot curing (steam)

in combination with Quality Seal S27.2

DANGER!

- **The instructions of the Industrial Safety Regulation – BetrSichV (previously steam boiler regulation) must be observed!**
- **RISK OF POISONING BY EXHAUST GASES!**
  Install the BRAWO® SteamUnit outside or ensure adequate removal of exhaust gases into the outside.
- **RISK OF FIRE!**
  Do not cover hot parts, never cover the exhaust chimney.
- **The steam generator must only be operated with filtered and demineralized water, that in addition must be offset with an oxygen binder!**
  - ⇨ **The use of unprepared water leads to calcium deposits (scale) and corrosion!**
  - ⇨ **Non-compliance can lead to the loss of function of the safety equipment (pressure relief valve, water shortage protection) and bursting of the pressure vessel!**

WARNING!

- **RISK OF SCALDING**
  due to hot water or steam.

CAUTION!

- **RISK OF BURNS due to hot parts.**

ATTENTION!

The required preconditions for use of the BRAWO® SteamUnit must be observed. The separate operating and maintenance instructions of the BRAWO® SteamUnit must be followed.

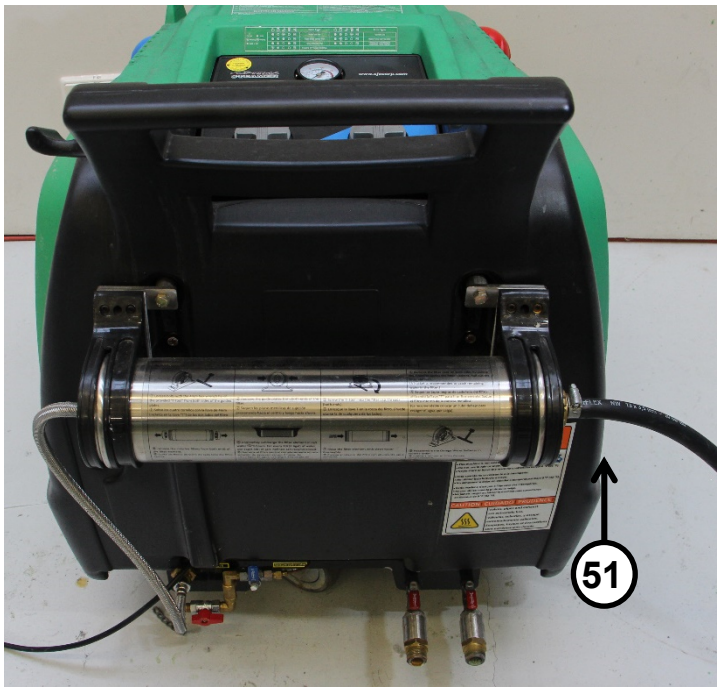
NOTE!

- **The BRAWO® SteamUnit is a diesel fired high-speed steam generator with a steam boiler as buffer storage.**
- **The steam generator has a heat-up time of approx. 10 - 15 minutes.**
- **The following steps 1 to 8 should be performed before the inversion process or parallel to it.**
- **When curing BRAWO® RR and BRAWO® SRR with steam, there is a risk of extreme temperature development as a result of the exothermic resin reaction. Therefore, curing with steam is not recommended.**

1. Set steam generator and BRAWO® Control on a suitable, horizontal area, protected from tilting, and block the brakes on the castors.

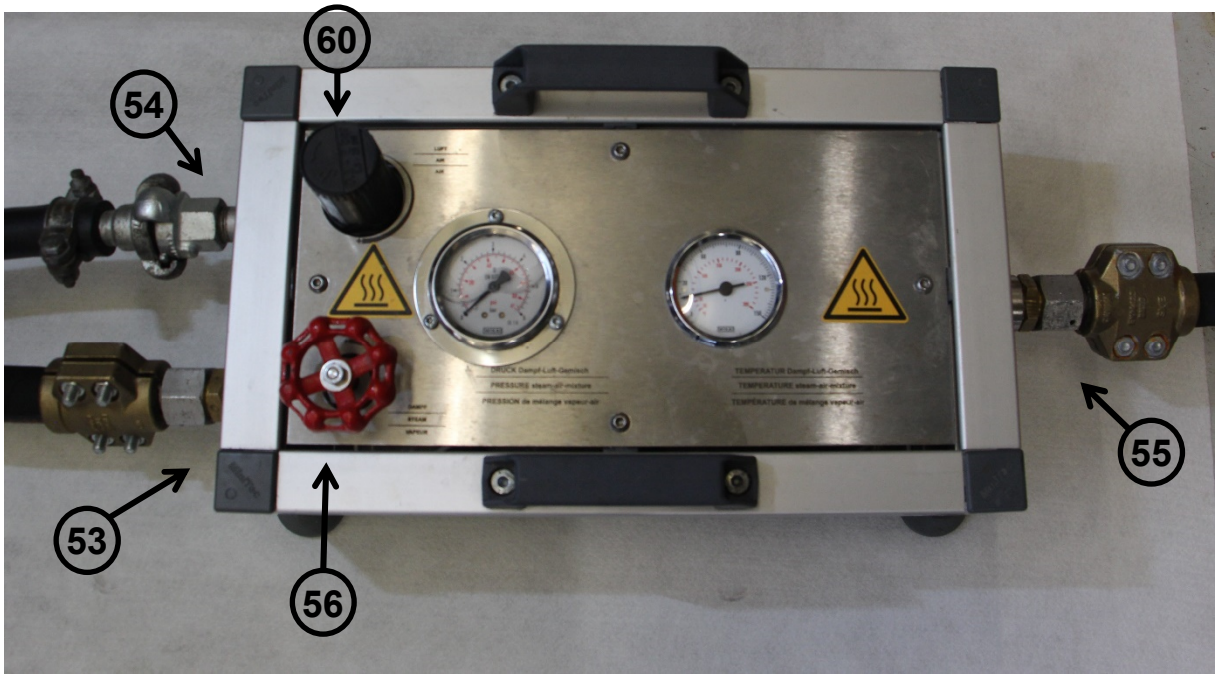
2. Connect the CIPP:

   a) Potable water faucet → Water inlet steam generator (Pos. 51)

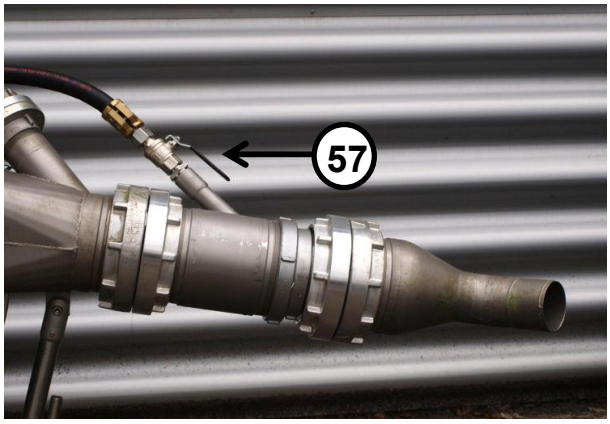


   b) Steam removal valve (Pos. 52) → Steam inlet BRAWO® Control (Pos. 53)

c) Compressor → air inlet BRAWO® Control (Pos. 54)



d) Removal valve BRAWO® Control (Pos. 55) → Steam inlet on intermediate piece (Pos. 57).



3. Make sure that the ball valve on the steam inlet on the BRAWO® Control (Pos. 56) is closed.

4. Turn on the “POWER” switch (Pos. 58) and the “STEAM” switch (Pos. 59) on the steam generator to switch on the power and the water pump. The water pump now pumps water into the boiler. When the water level reaches the upper water sensor, the water pump stops. When the required pressure (approx. 8 bar) is reached, the heating up stops.

NOTE!

- **The steam temperature and the steam boiler pressure are directly dependent on each other.**
- **To be able to mix steam in the flowing air the steam pressure must always be above the air pressure set on the control unit.**

5. Open the steam inlet on the intermediate piece (Pos. 57).

6. Set the air quantity on the pressure control valve of the BRAWO® Control (Pos. 60). Close the air supply on the inversion drum (Pos. 03).

7. Dose the steam to the already flowing air using the steam control valve (Pos. 56).

NOTE!

- **The interior pressure of the liner / calibration CIPP must be regulated when using the BRAWO® Steam sleeve by the quantity of the steam-air mixture flowing in and kept constant according to the recommendations on page 25 and page 31.**
- **The temperature of the steam-air mixture must be regulated on the steam inlet of the inversion equipment to approx. 80 °C.**
- **The maximum thermal stability of the old pipe must be observed!**
- **The maximum temperature resistance of the calibration CIPP must be observed!**

8. Adjust the pressure in the BRAWO® Inversion drum and the temperature on the steam inlet by regulating on the air control valve (Pos. 60) or the steam control valve (Pos. 56) to the above mentioned target values.

9. The required **total heating period** is made up as follows:

	Heat up time
+	**Curing time**
=	**Total heating period**

ATTENTION!

HEAT UP TIME:
It is dependent on the length and ambient conditions of the rehabilitation section as well as the diameter of the inverted BRAWOLINER® HT.

It is recommended to measure the actual existing temperature between the liner and the old pipe.

ATTENTION!

CURING TIME:
Only after the end of the BRAWOLINER® HT facing the steam inlet has reached the recommended temperature (=heat-up time), does the curing begin.

- **BRAWO® I:** **approx. 100 minutes at 50 °C**
  approx. 45 minutes at 70 °C
- **BRAWO® III/ AC:** **approx. 220 minutes at 50 °C**
  approx. 140 minutes at 70 °C
- **BRAWO® HT:** **approx. 140 minutes at 50 °C**
  approx. 80 minutes at 70 °C
- **BRAWO® TC:** **approx. 540 minutes at 60 °C**
  approx. 300 minutes at 70 °C

NOTE!

Observe the data for the curing time of the BRAWO® resins during hot curing.
For this refer to the *section 3.3.4 "Resin types"* on *page 22* or the technical data sheets of the BRAWO® resins.

10. After the curing time has elapsed, check the strength of the inversed **BRAWOLINER® HT** (on the piece that protrudes out of the rehabilitated pipe). When the **BRAWOLINER® HT** can no longer be shaped by hand, the curing process is completed and the cooling process can be started.

11. Turn off the steam generator and close the steam removal valve (Pos. 52).

12. The air volume flow (or interior pressure) can be increased for fast cooling on the pressure control valve (Pos. 60). Do not exceed the maximum internal pressure of approx. 0.6 bar. After cooling to approx. 35°C the interior pressure can be bled.

13. Variant dependent:

- **Variant "BRAWO® steam sleeve in the BRAWOLINER® HT"**

  Open the **BRAWOLINER® HT** on the end of the rehabilitation section, remove the BRAWO® Steam sleeve and pull back the retaining strap.

- **Variant "BRAWO® Steam sleeve in the calibration CIPP"**

  Pull the calibration CIPP under low pressure (approx. 0.05 bar) out of the **BRAWOLINER®** by turning back.

14. Open the CIPP clamps on the inversion pipe.

15. Cut the **BRAWOLINER®** flush with the old pipe. Equalize unevenness in the bottom area if necessary (e.g. with cement mortar).

16. 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 epoxy resins used are the so-called reaction resins.

7.1.0 What are reaction resins?

Reaction resins consist generally of 2 components and are mixed and processed in the liquid state at 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 Influence of the temperature on the pot life

The chemical reaction begins after mixing the components (=curing time). The pot life is an indication for the respective processing and curing times of the epoxy resins. The pot lives indicated here are values measured in a laboratory, which are determined from mixtures of 100 g.
The higher the ambient temperature, or the larger the resin quantity that is mixed, the faster the chemical reaction (=the curing). Thus with increasing quantity of resin the theoretical processing time and curing time is also strongly shortened.

Rule of thumb:

A temperature increase of 10 °C halves the pot life.

A temperature decrease of 10 °C doubles the pot life.

7.3.0 Processing instructions

NOTE!

Observe the technical datasheets of the corresponding resins.

When handling these resins the safety rules must be observed. Refer to *section 2.4.0 "Sources of danger – Accident prevention"* on *page 7*.

ATTENTION!

- **The mixture ratios must be followed!**
- **A change of the hardener quantity has no influence on the curing speed, rather it leads to a degradation of the material properties.**
- **When using BRAWO® TC the hardener must be completely stirred and only then added to the master.**

Storage:

Storage must be frost-free, the storage temperature ideally between +5 °C and +30 °C.

Processing:

The processing time of the resin mixtures is influenced by:

- **the processing temperature**

  Before processing, bring the components to +13 °C to +15 °C. We recommend storing in a climate controlled cabinet for temperature control.

ATTENTION!

Before processing always check the resin temperature and record it.

- **the batch size:**

  Keep the batch quantity small (do not pour containers together)

- **the mixing time:**

  The mixing time should be 3 minutes. Work with a slowly running stirring unit, e.g. BEBA mixer double-barreled.

ATTENTION!

- **Wipe down the floor and the side walls of the resin container when mixing with the mixer.**
- **During the mixing process always make sure no air gets stirs into the resin.**

- **the ambient temperature:**

  With higher outside temperatures work in the shade and do not leave containers in the sun. With cold curing also the temperature in the channel must be observed.

To determine the required resin quantity refer to the ***section 7.5.0 "Resin"*** on ***page 98***.

7.4.0 Influence of the curing temperature on the resin properties

In general it can be said that up to a certain limit the following applies:

NOTE!

The warmer an epoxy resin is cured, the better the mechanical, thermal and chemical properties are.

E-module, creep behavior, thermal dimensional stability and chemical resistance are thus improved.

A subsequent tempering step (warming after completed curing process) also improves the properties.

ATTENTION!

- **With resin collections - especially with BRAWO® RR, BRAWO® SRR, and BRAWO® I - very high reaction temperatures can in the resin can occur.**
- **Especially with steam curing these temperature peaks cannot be dispersed.**
- **We recommend to cure these resins at lower temperature, or to perform the curing with warm water.**
- **A curing temperature >°70°C should be avoided.**

7.5.0 Resin consumption BRAWOLINER®

BRAWOLINER® / BRAWOLINER® HT

DN	To achieve wall thickness of min. 3 mm			Reduced wall thickness *) min. 2mm	
	Roller distance	BRAWO® I BRAWO® III BRAWO® RR BRAWO® SRR in kg / m	BRAWO® HT in kg / m	Roller distance	BRAWO® HT in kg / m
50	7.0mm	0.5	0.6	4.2mm	0.3
70	8.5mm	0.8	0.9	6.5mm	0.6
100		1.1	1.3		1.0
125		1.4	1.6	7.0mm	1.2
150		1.7	2.0		1.5
200		2.3	2.7		2.0

BRAWOLINER® 3D / BRAWOLINER® HT 3D

DN	To achieve wall thickness of min. 3 mm			Reduced wall thickness *) min. 2mm	
	Roller distance	BRAWO® I BRAWO® III BRAWO® RR BRAWO® SRR in kg / m	BRAWO® HT in kg / m	Roller distance	BRAWO® HT in kg / m
70-100	10.0mm	0.9	1.1	7.0mm	0.7
100-150	12.0mm	1.5	1.8	10.0mm	1.4
150-225		2.3	2.7		2.2

*) to especially avoid excessive resin collections in the inlets of down pipes with smaller nominal diameters (DN40-DN70), it is recommended to impregnate the liner with reduced roller spacing and reduced resin quantity.

BRAWOLINER® 3D DN 200-300

DN	To achieve wall thickness of min. 4.7 mm	
	Roller distance	BRAWO® I BRAWO® III in kg / m
200-300	14mm	4.1

BRAWOLINER® 3D DN 300-400

DN	To achieve wall thickness of min. 5.1 mm		
	Roller distance	BRAWO® AC in kg / m	BRAWO® TC in kg / m
300-400	15.5mm	7.1	7.5

BRAWOLINER® XT / BRAWOLINER® HT XT

DN	To achieve wall thickness of min. 4 mm		
	Roller distance	BRAWO® I BRAWO® III BRAWO® RR BRAWO® SRR in kg / m	BRAWO® HT in kg / m
100	11.0mm	1.7	2.0
125		2.0	2.4
150		2.3	2.8
200		3.1	3.7

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

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®			Page:	**Weather**	Deployment manager:
Hot curing (water) ☐	**Hot curing (steam)** ☐		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:	Length:	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:				

Number of pumps: Qty.	Sealing balloons: Qty.	Pump lines: m	Distance water connection [m]:	Distance heating system [m]:

Material Material specification by Cus. ☐ Cont./site manager ☐ Cont./polisher ☐ Comments:

Liner	Brawoliner ☐	Brawoliner 3D ☐	HT variant ☐	Nominal diameter DN:	**Resin**	Batch No.: Comp. A:	Brawo I	Brawo III	Brawo HT	Brawo AC	Brawo TC	Brawo RR	Brawo SRR
	Brawoliner XT ☐	Connection sl. ☐		Batch number case:		Batch No.: Comp. B:							

Installation

Preliner used	YES	NO	*Comments:*
End: Open	Sleeve	Closed	
Calibration hose	YES	NO	
Waste water-free?	YES	NO	
Resin storage temperature (TARGET: 5°C - 30°C).		°C	
Resin temperature before installation (TARGET: 13 - 15°C):		°C	
Mixing ratio [A:B]:	:		

Resin quantity in [kg/m]:		Total [kg] TARGET:	A [kg] ACTUAL:	B [kg] ACTUAL:
Mixing time (TARGET: 3 min):	min	roller spacing TARGET: mm	roller spacing ACTUAL: mm	
vacuum (TARGET: 0,5 bar, 5 min. before/during impregnation)	bar			

Processing time in Liner:	Brawo I (max. approx. 50 min at 15°C)	Mixing start:	Installation time:
	Brawo III (max. approx. 3.5 h at 15°C)	Mixing start:	Installation time:
	Brawo HT (max. approx. 70 min at 20°C)	Mixing start:	Installation time:
	Brawo RR (max. approx. 30 min at 15°C)	Mixing start:	Installation time:
	Brawo AC (max. ca. 2-2,5 h bei 15 °C)	Mixing start:	Installation time:
	Brawo TC (max. ca. 8 h bei 15 °C)	Mixing start:	Installation time:

Inversion pressure (TARGET: 0.2 - 0.3 bar): bar	Inversion with water column (TARGET: 2 - 3 m): m

Sketch

Curing

Curing condition:	HOT	Water	Steam	COLD			
Curing temperature:	°C			°C			
Curing time hot:	Brawo I (approx. 45 min at 70°C)	Brawo III/AC (approx. 140 min at 70°C)		Brawo TC (approx. 300 min at 70°C)	Brawo HT (approx. 80 min at 70°C)	-	-
Curing time hot:	Brawo I (approx. 100 min at 50°C)	Brawo III/AC (approx. 220 min at 50°C)		Brawo TC (approx. 540 min at 60°C)	Brawo HT (approx. 140 min at 50°C)	Brawo RR (approx. 75 min at 50°C)	BRAWO SRR (appr. 50 min at 50°C)
Curing time cold:	Brawo I (approx. 13 h at 10°C)	Brawo III/AC (approx. 24 h at 10°C)		-	Brawo HT (approx. 20 h)	Brawo RR (approx. 6 h at 10°C)	BRAWO SRR (appr. 2 h at 20°C)
Curing time ACTUAL:							
Curing pressure (TARGET 0.3 - 0.4 bar):	bar	Water column (TARGET: 3 - 4 m):		m			