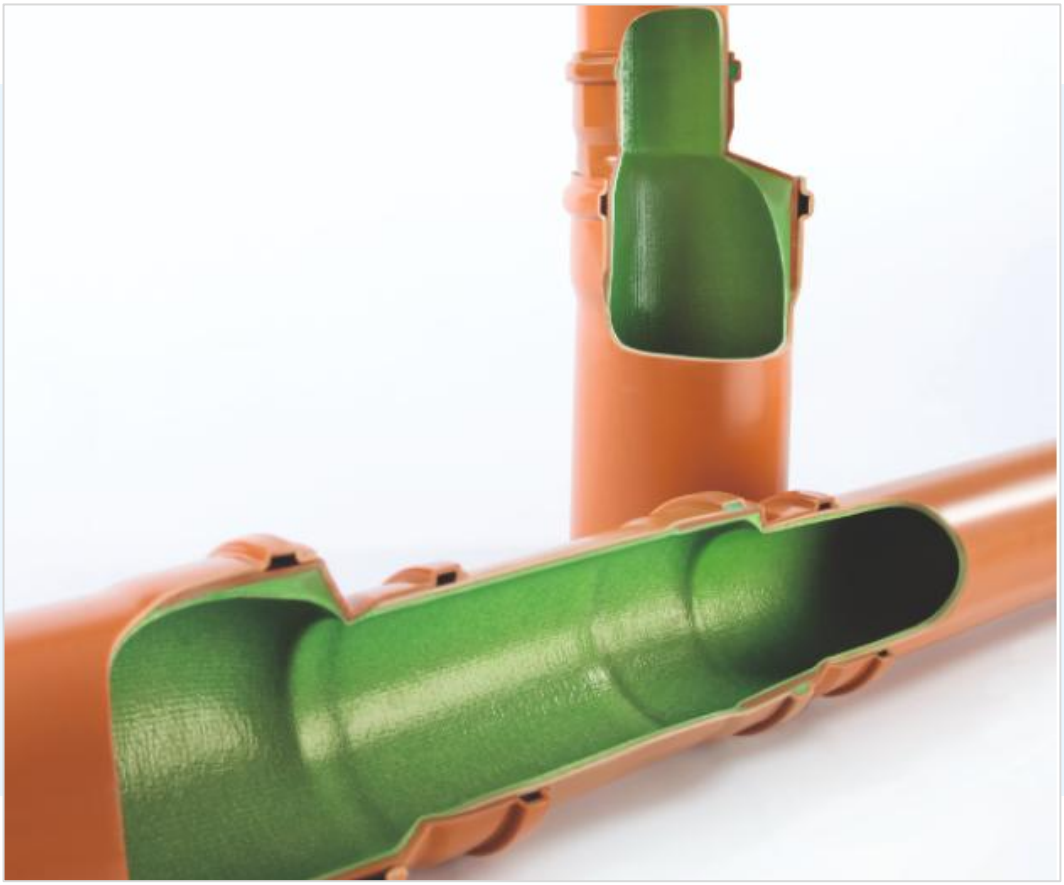
BRAWO® SYSTEMS

Process Instructions

BRAWOLINER® rehabilitation process



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BRAWO® SYSTEMS GmbH · Blechhammerweg 13 – 17 · D-67659 Kaiserslautern · T: +49 631 20561-100

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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 carrying out 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.

Special information regarding economic operation and important additional information.

2.2.0 Proper use

- The BRAWO® inversion drum / Drum 4.0 / the BRAWO® tripod 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 also includes compliance with inspection and maintenance conditions, as well as compliance with the safety instructions set out in these 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.
- **There is a risk of crushing when moving the inversion drum, in particular**
  on 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**

- **BRAWO® tripod**

DANGER!

- **DANGER OF SCALDING!**
  due to hot water!
- **DANGER OF TIPPING OVER!**
  Always ensure the BRAWO® tripod is standing securely.
- **DANGER OF FALLING!**
  when working on scaffolding or ladders

- **Epoxy resin**

DANGER!

GHS 05

GHS 07

GHS 08

GHS 09

- *Causes severe skin burns and eye damage.*
- *Causes skin irritation.*
- *May cause damage to organs in case of prolonged or repeated exposure.*
- *Causes serious eye irritation.*
- *Harmful by ingestion.*
- *Can probably affect fertility. Can probably harm the child in the womb.*
- *Toxic to aquatic life with long lasting effects*

⇨ **Wear protective gloves/eye protection/face protection.**
⇨ **Do not eat, drink or smoke during work.**
⇨ **Avoid inhalation of dust/smoke/gas/mist/vapour/aerosol.**
⇨ **Prevent release into the environment.**

⇨ **Ensure good ventilation during mixing.**
⇨ **Comply with current safety data sheets.**

- **BRAWO® HotBox**

DANGER!

- **DANGER OF POISONING DUE TO EXHAUST FUMES!**
  Set the BRAWO® HotBox up outdoors or ensure that the exhaust fumes are suitably discharged to the outdoors.
- **DANGER OF FIRE!**
  Never cover the exhaust fumes chimney.

CAUTION!

DANGER OF BURNS!
due to hot parts.

- **BRAWO® SteamGenerator**

DANGER!

- **DANGER OF POISONING DUE TO EXHAUST FUMES!**
  Set the BRAWO® SteamGenerator up outdoors or ensure that the exhaust fumes are suitably discharged to the outdoors.
  Do not inhale exhaust fumes.
- **DANGER OF FIRE!**
  Do not cover hot parts, never cover the exhaust fumes chimney.

WARNING!

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

CAUTION!

WARNING!

- **DANGER OF BURNS!**
  due to hot parts.
  Staying in the shaft during installation and curing of the liner must be avoided as a matter of principle. Especially in the case of warm curing, there is a risk of injury, particularly scalding, in the event of a burst.

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.

- **Epoxy resin**

ATTENTION!

CAUSTIC EFFECT / HEALTH HAZARD!

- **Face protection**
- **or tightly sealing safety goggles**
- **suitable protective clothing, e.g. chemical-resistant protective suit**
- **Use chemical-resistant protective gloves tested according to EN 374, e.g. made of nitrile rubber.**
- **Wear a 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.

- **BRAWO® SteamGenerator**

ATTENTION!

DANGER OF BURNS AND SCALDING!

- **Face protection**
- **or tightly sealing safety goggles**
- **Use protective gloves**

2.4.3 First-aid measures (epoxy resin)

- **General information:**

  Epoxy resins can cause chemical burns, as well as 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:**

  Provide plenty of fresh air and call a doctor for safety reasons. If unconscious, place and transport person in a stable side position.

- **After skin contact:**

  Wash off immediately with water and soap, rinse thoroughly. Do not use diluting agents or solvents to clean the skin.

  In case of large-area skin contact, skin redness or itching, consult a doctor.

- **After eye contact:**

  Call a doctor immediately. Rinse eyes under running water with the eyelid slit open.

- **After swallowing:**

  Call a doctor immediately. Rinse mouth with water. Drink plenty of water and provide fresh air.

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

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

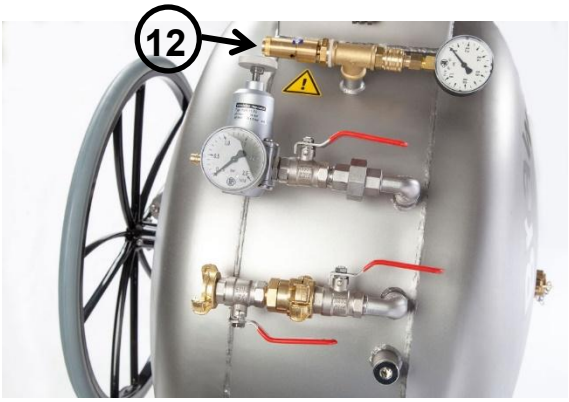
Emergency poison line (+49) 6131 19240

2.4.4 Safety equipment

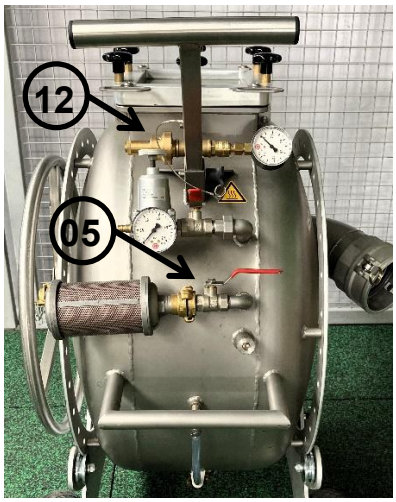
ATTENTION!

- **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.**
- **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

The inspection glass seal must be checked each time before putting the unit into operation.

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 to operate the inversion process.

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, vacuum pump, BRAWO® HotBox, BRAWO® SteamGenerator and the circulation 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® system covers the trenchless rehabilitation of house connection pipes, as well as the non-destructive rehabilitation of downpipes and connection pipes inside buildings. Ducts and pipes in the dimensions of DN 50 to DN 400, 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-42.3-362 (DN100 - DN400)
(Rehabilitation of underground damaged wastewater pipes)

DIBt approval No.: Z-42.3-499 (DN50 - DN200)
(Rehabilitation of damaged sewage, rainwater and collecting pipes inside buildings)

The damaged pipes must be appropriately prepared (cleaned, ...) before inversion takes place. The BRAWOLINER® is soaked with epoxy resin. The resin is distributed uniformly over the entire hose length using the BRAWO® impregnation unit.

- **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.

- **Installation with BRAWO® tripod (water gravity)**

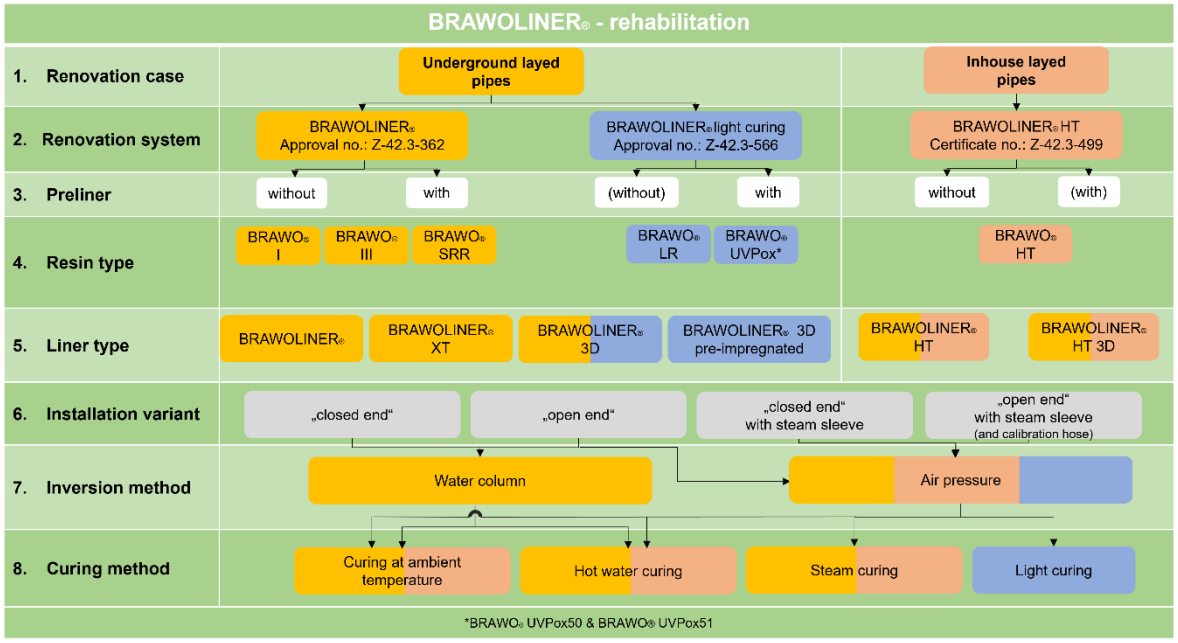
  The pretreated BRAWOLINER® is introduced into the BRAWO® tripod and inversed into the damaged pipe by means of hydrostatic pressure.

The BRAWOLINER® thereby lines the existing pipe wall. The curing times of the epoxy resins depend on the ambient temperature and can fluctuate greatly. See ***Chapter 7.0.0 "Important information about reaction resins"*** on ***Page 97***.

Very short and constant curing times can be achieved with the use of our optionally available warm water heating system (BRAWO® Hotbox) or steam heating system (BRAWO® SteamGenerator).

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

3.3.0 Schematic process plan



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 BRAWO® LR and BRAWO® UVPox light-curing resin systems, observe the respective process instructions in a separate document.

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.

ATTENTION!

Waste water pipes with pipe penetration seals that foam up in the case of fire (e.g. pipe cuffs) may not be renovated. The specifications in the directive on fire protection requirements pertaining to conduits for the respective federal states must be taken into account.

3.3.2 Renovation system

The BRAWOLINER® process can be divided into two areas:

1. BRAWOLINER® system

The BRAWOLINER® system enables the rehabilitation of underground damaged wastewater pipes ***outside*** 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 wastewater pipes (sewage, rainwater and collecting pipes) ***inside*** the building structure.

DIBt approval number: Z-42.3-499

NOTE!

The differences between the rehabilitation systems are only in the materials used and, if applicable, in the curing process.

Requirements for wastewater pipes inside the house require the use of the BRAWOLINER® HT rehabilitation system depending on the local regulations.

3.3.3 Preliner

NOTE!

- **In zones saturated with groundwater (groundwater infiltration), a preliner must be introduced in advance of the rehabilitation process.**
- **The use of a preliner is not recommended when renovating downpipes as it cannot bond to the old pipe.**

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 39***.

3.3.4 Resin types

The following resins can be selected according to requirements:

Resin types and application areas										
BRAWO® Resin type	Underground pipes	Indoor pipes	Connecting pipes	Pipe length: Less than 5 m	Pipe length: less than 15m	Pipe length: More than 15m	processing time Soaked liner	Curing time Cold curing	Curing time Hot curing 50°C	Curing time Hot curing 70°C
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	**3.5h at 15 °C**	**24 h at 10 °C**	**220 min**	**140 min**)**
BRAWO® HT		X	X	X	X	X	**70 min at 20 °C**	**18 h at 15 °C**	**140 min**	**80 min**)**

*) Can only be used for BRAWOLINER® 3D DN 300-400

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

***) Attention: With BRAWO® SRR there is a risk of extreme temperature development as a result of the exothermic resin reaction when curing with steam. Curing with steam is therefore not recommended.

(X) Limited processing time! Recommended only for favourable conditions

NOTE!

- **BRAWO® SRR / I / III mixing ratio: 3:1 (Mass fraction of component A:B)**
- **BRAWO® HT mixing ratio: 5:1 (Mass fraction of component A:B)**
- **Excessive reaction temperatures must be avoided (exothermic).**

The processing instructions, required resin quantities and roller spacings can be found in the ***Chapter 7.0.0 "Important information about reaction resins"*** starting on ***Page 97***.

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	Liner name	Underground pipes	Building pipes	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	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 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	X	X	X		X	X										
	DN 100	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				

*) When using a suitable calibration hose

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®/ 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

*Heating favours the expansion process. In the case of light curing, a higher curing pressure may have to be applied.

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 34.**
- **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 curing with water, the height differences between the start and finish points must be taken into account.**
- **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 4 variants for completing the ends of the BRAWOLINER® and the calibration hose, dependent on the accessibility of the liner end and the curing method.

- For hot curing (water), a hose (Ø approx. 20 mm, GEKA connection on one side, water outlet on the BRAWOLINER® end) is needed for circulation.
- For steam curing, the BRAWOLINER® or calibration hose must be fitted with a BRAWO® steam sleeve to allow a flow through and to drain any condensate.

For detailed instructions on implementing the knots and inclusion of the BRAWO® steam sleeve, see **Chapter 4.4.0 "Installation process - Guideline"** starting on **Page 34**.

3.3.6.1 Calibration hose

The calibration hose is a 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.

It can be used as an additional protection of the liner foil during steam curing. A temperature-resistant calibration hose must be used for hot curing.

For more information on the installation process, see ***Chapter 4.9.1 "Inversion of the calibration hose with BRAWO® inversion drum"*** starting on ***Page 72***.

3.3.6.2 Installation variant "Closed end"

For applications where:

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

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 (+ hose for hot curing) on the BRAWOLINER® end

3.3.6.3 Installation variant "Open end"

For applications where:

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

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 (+ hose for hot curing) on the calibration hose end

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

For applications where:

- BRAWOLINER® end accessible
- Heat curing with steam

This variant can be used in warm curing with steam if it is possible to open the end. The BRAWO® steam sleeve is fastened in the end of the BRAWOLINER ®so that steam and condensate can escape. A constant volume flow is necessary to maintain the contact pressure in the pipe.

Setup type:

⇨ "BRAWO® steam sleeve in the BRAWOLINER® HT

⇨ Calibration hose not required

⇨ Fasten retaining strap on the BRAWOLINER® HT end

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

For applications where:

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

This variant can be used for hot curing with steam if it is ***not*** possible to open the end. 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. The BRAWO® steam sleeve is fastened in the end of the calibration hose so that steam and condensate can escape. A constant volume flow is necessary to maintain the contact pressure in the pipe.

Setup type:

⇨ "Open end" BRAWOLINER®

⇨ BRAWO® steam sleeve in the calibration hose end

⇨ Fasten the retaining strap to the end of the calibration hose

3.3.7 Necessary installation equipment

Necessary devices:

1. Compressor (min. 1300 l/min for steam curing)
2. Power generator, alternatively mains supply 230V
3. Cordless screwdriver
4. Inspection camera

Always required:

1. **BRAWOLINER®** / **BRAWOLINER® HT**
2. BRAWO® resins
3. Stirrer (e.g. BEBA mixer - reversible action)
4. Vacuum pump
5. Fabric adhesive tape
6. BRAWO® impregnation unit (electric or manual)
7. BRAWO® inversion drum (compressed air) ***or*** BRAWO® tripod (water column)
8. Retaining strap and circulation hose
9. Climate chamber for temperature control of resins
10. BRAWO® curing unit (hot curing water/steam)

Optionally required:

1. Preliner
2. Calibration hose
3. BRAWO® resin mixing unit
4. Connection cuffs
5. BRAWO® curing units (e.g. HotBox, SteamGenerator) incl. accessories
6. BRAWO® VortexCutter
7. Milling robot (e.g. IMS Micro)
8. 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 process

The resin is cured through a chemical reaction between Component A and Component B, starting when the components are being mixed. The resin temperature can be used to influence the time range for the curing process. For more information, see ***Chapter 7.0.0 "Important information about reaction resins"*** on ***Page97***.

Three curing methods are available for selection:

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

   When **curing at ambient temperature**, the inversed BRAWOLINER remains® pressurized until completely cured. No additional heat is added.

2. **Hot curing (water) (according to quality seal S27.1)**

   During hot curing (water), the hot water heating system, BRAWO® HotBox, is used. The liner is fully filled with water that is circulated and heated in the BRAWO® Hotbox by means of a circulation pump. The curing time is considerably shortened by the introduced heat.

3. Steam curing (according to quality seal S27.2)

During steam curing, the BRAWO® SteamGenerator is used. Use is recommended only when using BRAWOLINER® with an additional calibration hose or BRAWOLINER® HT. A steam-air mixture flows through the inversed liner. This curing method is used when the height difference between the start and end of the pipe is over 4 metres, and the use of water as a source of heat is no longer possible.

A guide to hot water and steam curing can be found in ***Chapter 4.10.0 "Hot curing"*** starting on ***Page 79*** and in ***Chapter 4.11.0 "Hot curing (steam)"*** starting on ***Page 87***.

4.0.0 Installation process - Guideline

These process instructions deal with the BRAWOLINER® process for **house connection rehabilitation** (BRAWOLINER® system) and for **in-house- rehabilitation** (BRAWOLINER® HT-system).

The installation of the BRAWOLINER® is the same for both 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.**
- **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 27 must be observed.**
- **The installation process described below is based on a normal case. 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 must be followed! We recommend that the renovation be documented. See also *Chapter 8.0.0 "Installation log"* on *Page 103*.**

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 39***.
7. Ensure that no sewage is introduced during the renovation. If necessary, block rainwater inlets.

4.2.0 Establishing operational readiness

BRAWO® inversion drum/ Drum 4.0

1. Place BRAWO® inversion drum / Drum 4.0 in position. Connect compressed air to the pressure control valve Pos. 03.
2. If hot curing (water) is planned, remove the side cover panel (GEKA) and connect the ball valve Pos. 02.
3. Ensure that all ball valves are closed.

BRAWO® tripod

1. Place the inversion unit in position, ensure an adequate water supply.

Subsequent procedure, see Point 4.

4. Get the matching inversion pipe, the coupling connector (when using the BRAWO® Drum 4.0), the inversion hose and, if applicable, the Storz coupling key, ready. For steam curing, an inversion pipe with steam inlet or an adapter with steam inlet must be provided or, in the case of the BRAWO® Drum 4.0, install the steam inlet on the steam inlet connection. The compressor (min. 1300 l/min) must be connected via the control unit to the steam inlet to maintain the internal pressure when the BRAWO® steam sleeve opening is released.

5. Apply detergent to the inversion pipe and feed in the guide rope (to pull through the liner later on).

6. Check that the retaining strap and water hose, where hot curing (water) is planned, are of sufficient length and lay them out ready for use. Care must be taken to ensure that the retaining strap and the water hose are of a sufficient length.

7. Dependent on curing method

   7.1. Cold curing:

   Attach the holding rope to the drum reel with one end and wrap several layers around the axle or get ready in case of inversion with BRAWO® tripod.

   7.2. Hot curing (water):

   Secure the start of the water hose in the drum using the GEKA connector on the reel. Attach the holding rope to the drum reel with one end and wrap several layers around the axle, then wrap onto the drum reel parallel to the water hose, or get ready in case of inversion with BRAWO® tripod. Ensure that the end of the water hose is secured to the retaining strap.

   7.3. Steam curing:

   Attach the holding rope to the drum reel with one end and wrap several layers around the axle.

8. Get suitable hose clips, cable ties, fabric adhesive tape and cordless screwdriver ready.

9. Prepare the transport bath (cold water with some detergent).

10. Set up the power supply.

11. Prepare BRAWO® resin mixing unit or Beba mixer.

12. Prepare BRAWO® impregnation unit.
13. Get BRAWO® SteamGenerator or BRAWO® HotBox ready for operation.
14. Check that the installation equipment is functional.

4.3.0 Preliner inversion

4.3.1 Inversion of a preliner with BRAWO® inversion drum / Drum 4.0

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

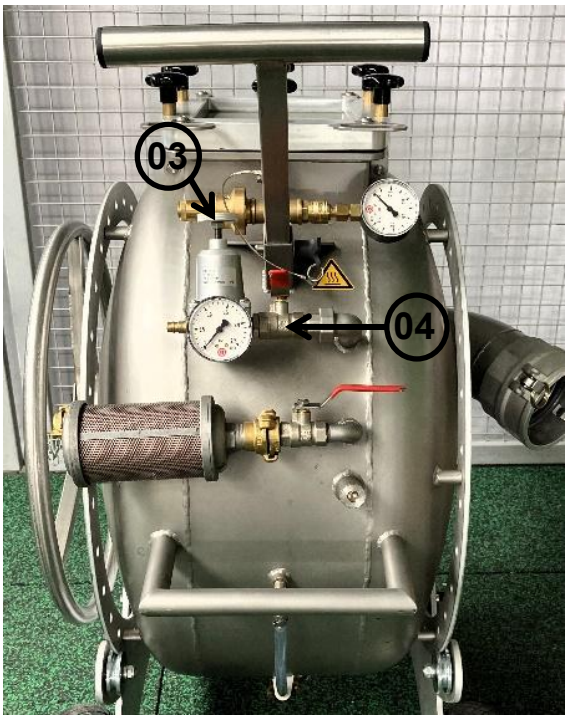
1. Wind the preliner with open end onto the drum axle. Do not connect the end of the preliner to the retaining strap!

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 (***see CAUTION!*** on ***Page 8***).



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 ball valve (Pos. 04).
9. Open the hose clips on the inversion pipe and attach the preliner to the shaft.

4.3.2 Inversion of a preliner with BRAWO® tripod

DANGER!

- **DANGER OF TIPPING OVER!**
  Always ensure the BRAWO® tripod is standing securely.
- **DANGER OF FALLING when working on scaffolding or ladders.**

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

Rehabilitation length + allowance for fastening to the inversion pipe

1. 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 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 (second operator).
5. The second operator gives the signal to start. The first operator then starts to fill the inversion hose with water. Inversion occurs with a water column of 2–3 m (≈ 0.2–0.3 bar).
6. The inversion speed can be controlled by the volume of water fed in.
7. Inversion is complete when the preliner reaches the end of the section under renovation and opens up. The water escapes and the preliner will collapse.
8. Open the hose clips on the inversion pipe and attach the preliner to the shaft.

NOTE!

Installation will only occur in the direction of flow!

4.4.0 Trim, seal and prepare the calibration hose for inversion

ATTENTION!

Only required if the installation option "Open end" or "Open end with BRAWO® steam sleeve" is used.

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 (15 cm when using the BRAWO® steam sleeve) for closing 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!

1. Trim the calibration hose.
2. Seal the end of the calibration hose (dependent on curing method):

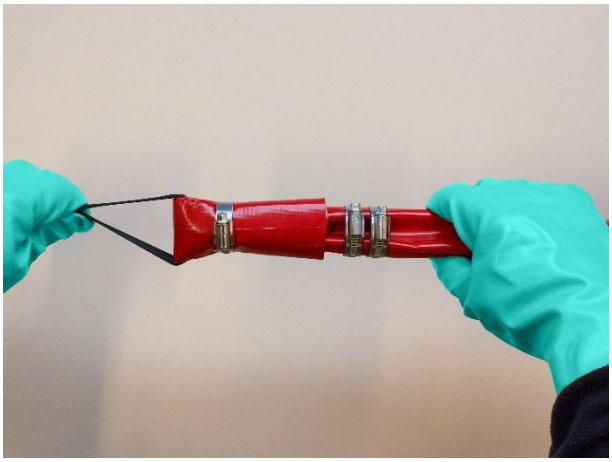
2.1. Curing at ambient temperature or hot curing (water) ("Open end BRAWOLINER®“ option)

Seal the end of the calibration hose so that it is air and pressure tight:

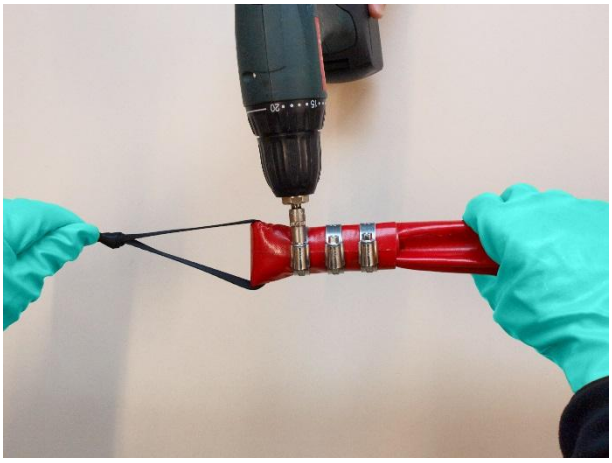
1. Fold the end of the calibration hose lengthwise.

2. Clamp the folded piece loosely with at least three hose clips. Connect retaining strap and calibration hose to each other by means of loops.

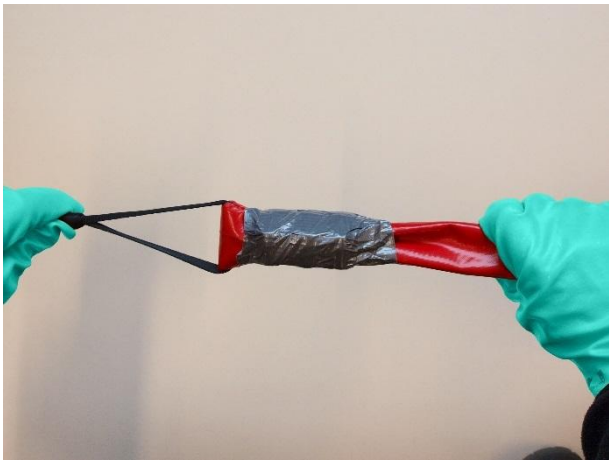
3. Pull the hose clamps over the folded part of the calibration hose.



4. Tighten the hose clamps evenly and tightly.



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

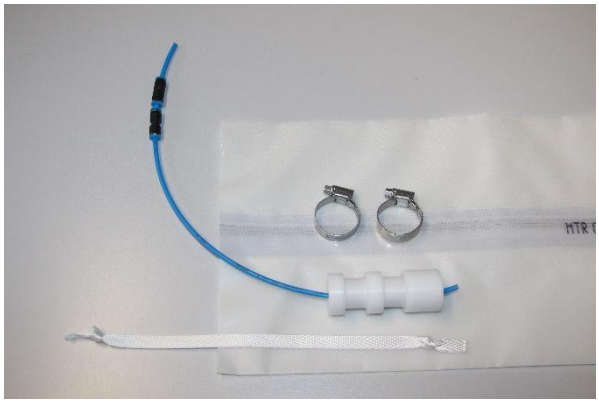


Wind the sealed calibration hose, looped together with the retaining strap, onto the drum axle over the retaining strap. Fasten the start of the calibration hose to the drum axle with adhesive tape. The BRAWOLINER® is then wrapped over it. For inversion using BRAWO® tripod, get the calibration hose ready.

2.2. Steam curing ("Open end BRAWOLINER® / BRAWO® steam sleeve in the calibration hose“ option)

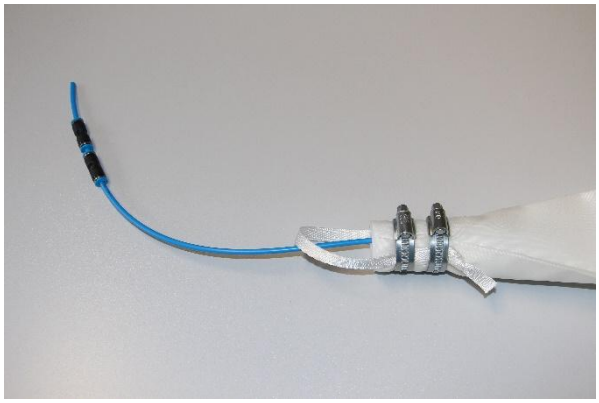
Fasten the BRAWO® steam sleeve in the end of the calibration hose. While doing so, ensure that the condensation tube lies externally.

1. Knot the end of the retaining cord and lay it out ready for use.

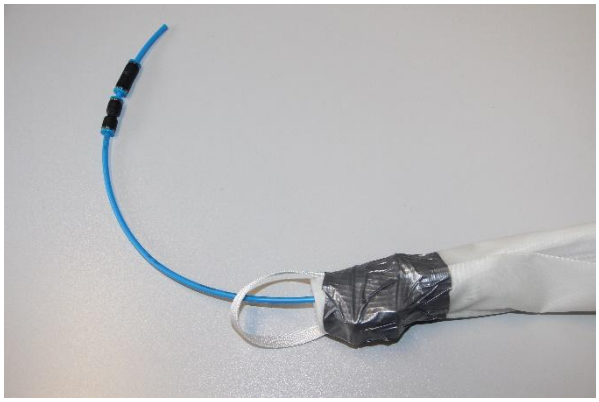


2. Place the BRAWO® steam sleeve into the calibration hose and fold it around it in an S-shape.

3. Cover the folded piece with hose clips and tie the retaining strap in with it. Make sure that the hose clips are located in the grooves of the BRAWO® steam sleeve.



4. Tighten the hose clips evenly and tightly and cut them off as short as possible. In order to avoid damage, tape over the hose clips.



ATTENTION!

It is essential to ensure that the calibration hose, the adhesive tape and the end of the retaining strap do not protrude from the sleeve. A projection > 1 mm must be cut off flush with the end of the sleeve, otherwise the bore in the sleeve may become blocked.

Wind the sealed calibration hose, looped together with the retaining strap, onto the drum axle over the retaining strap. Fasten the start of the calibration hose to the drum axle with fabric adhesive tape. The BRAWOLINER® is then wrapped over it.

4.5.0 Trim the BRAWOLINER®, seal it and prepare for impregnation

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

"Open end" (cold, hot water or steam curing):

	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®**

"Closed end" (cold, hot water or steam curing):

	Renovation length
+	**Allowance for attaching to the inversion pipe**
+	**approx. 40 m for sealing (alternatively 15 cm to bind in the BRAWO® steam sleeve)**
=	**Length of the BRAWOLINER®**

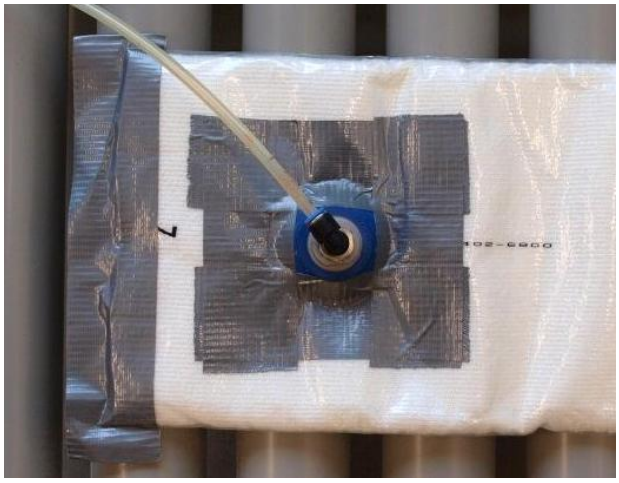
NOTE!

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 a fabric 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 fabric 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)

7. 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 Impregnating the BRAWOLINER®

DANGER!

Epoxy resin

GHS 05

GHS 07

GHS 08

GHS 09

- *Causes severe skin burns and eye damage.*
- *Causes skin irritation.*
- *May cause damage to organs in case of prolonged or repeated exposure.*
- *Causes serious eye irritation.*
- *Harmful by ingestion.*
- *Can probably affect fertility. Can probably harm the child in the womb.*
- *Toxic to aquatic life with long lasting effects*

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

⇨ **Do not eat, drink or smoke during work.**

⇨ **Avoid inhalation of dust/smoke/gas/mist/vapour/aerosol.**

⇨ **Prevent release into the environment.**

⇨ **Ensure good ventilation during mixing.**

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

ATTENTION!

CAUSTIC EFFECT / HEALTH HAZARD!

- **Face protection**
- **or tightly sealing safety goggles**
- **protective clothing**
  e.g. chemical-resistant protective suit

- **Use chemical-resistant protective gloves tested according to EN 374, e.g. made of nitrile rubber.**
- **Wear a type A filter mask, based on the danger and risk of exposure.**
- **Comply with the current safety data sheet.**

ATTENTION!

The resin starts reacting as soon as the resin components are mixed. It is essential to work quickly.

1. Calculate the necessary amount of resin. See ***Chapter 7.5.0 "Resin"*** on ***Page 101***.
2. Mix the determined quantities of components A and B, taking into account ***Chapter 7.3.0 "Manufacturing instructions"*** on ***Page 98***.

3. Fill the BRAWOLINER® with resin.
4. Unfold the rim at the filling end again to prevent possible leakage of the resin.
5. Distribute and work in the resin with the BRAWO® impregnation unit. Select and set the roller spacings in accordance with ***Chapter 7.5.0 "BRAWOLINER® resin consumption"*** on ***Page 101***. Normally, one to two roller 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 / Drum 4.0 in the transport bath.

4.7.0 Sealing the BRAWOLINER® end

4.7.1 Closed end DN 50-70

It is important to create the slimmest, most flexible liner end possible, especially for the installation of the BRAWOLINER® DN 50 and DN 70.

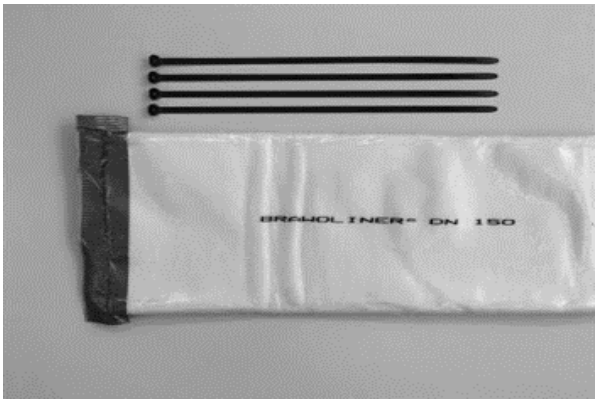
1. Seal the BRAWOLINER® airtight with fabric adhesive tape, knot the end of the retaining strap and lay it on the BRAWOLINER®.

2. Fold the BRAWOLINER® around the retaining strap. Protect the BRAWOLINER® before and after the inserted knot with fabric adhesive tape against damage. Firmly secure the BRAWOLINER® on the adhesive strips with cable ties so that the knot cannot slip out.

3. To avoid damage, tape over the cable binders.

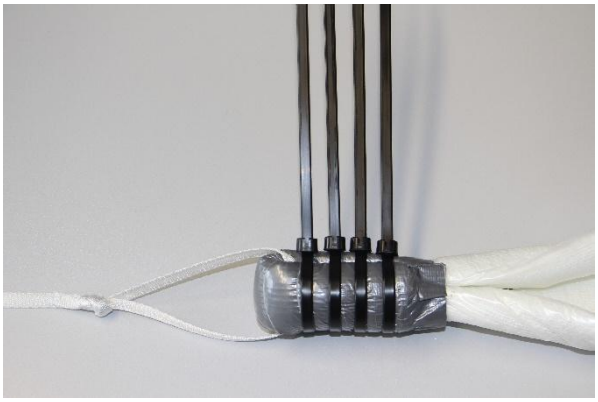
4.7.2 Closed end DN 100-200

1. Seal the end of the BRAWOLINER® airtight.

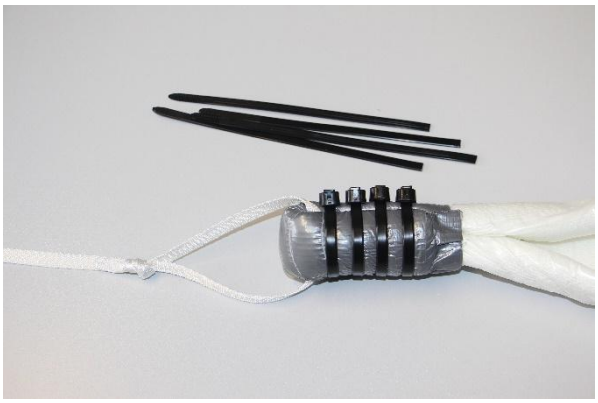


2. Fold the BRAWOLINER® lengthwise and wrap it with fabric adhesive tape.

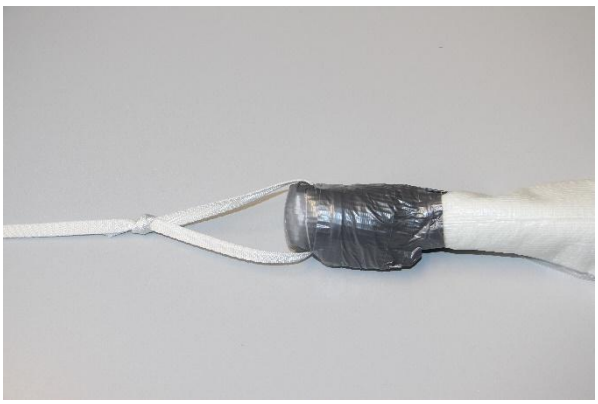
3. Connect retaining strap and BRAWOLINER® to each other by means of loops. Firmly secure the loop with cable ties.



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

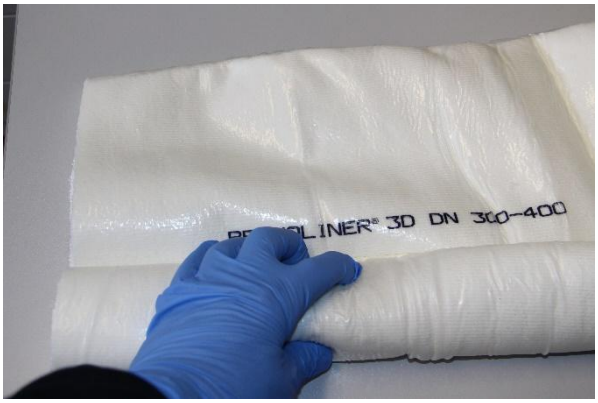


5. Completed knot



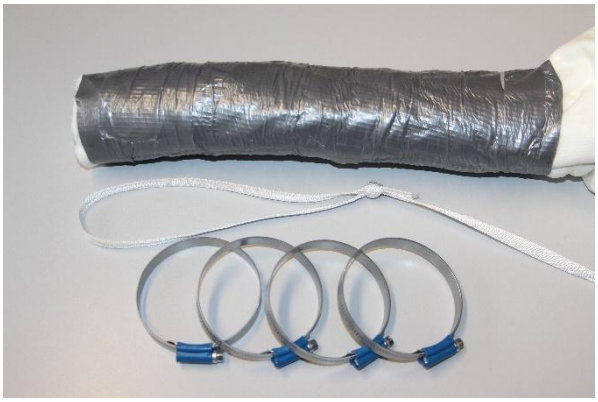
4.7.3 Closed end DN 200-300, DN 300-400

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

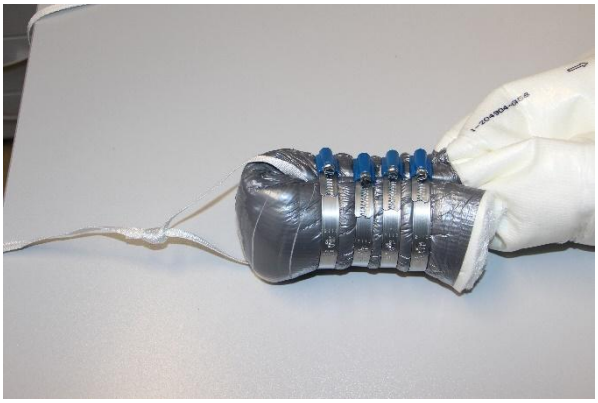


2. Fold the other side of the BRAWOLINER® to form an "S".

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



4. Insert a loop into the BRAWOLINER® (for later connection to the retaining strap) and seal tightly with hose clips.



5. To prevent damage, mask the hose clips with fabric adhesive tape until no sharp edges can be felt.

4.7.4 Open end

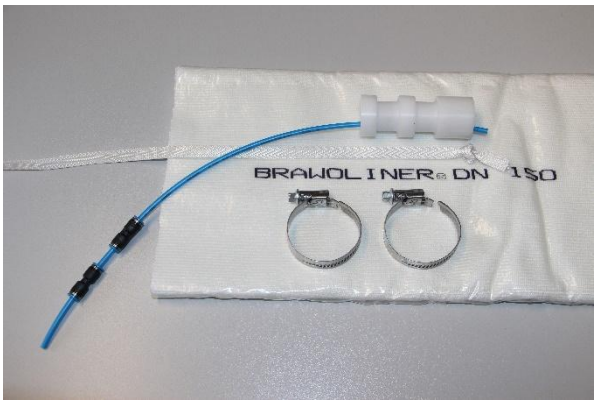
1. Cut off the end of the BRAWOLINER® at the marked liner length (rehabilitation length + allowance for attachment to the inversion pipe). Ensure that the liner is completely saturated with resin past the mark.

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!

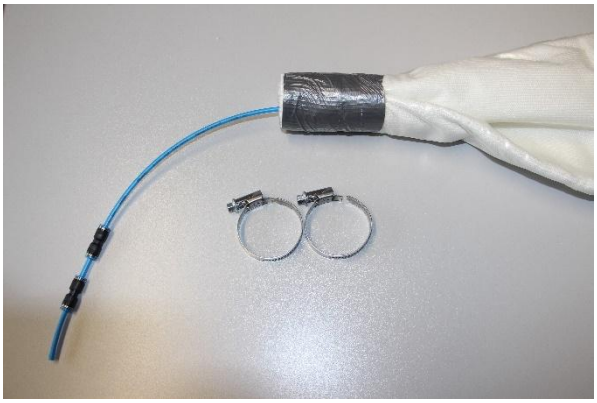
4.7.5 BRAWO® steam sleeve in the BRAWOLINER® DN 50-70 and DN 100-250

1. Knot the end of the retaining cord and lay it out ready for use.

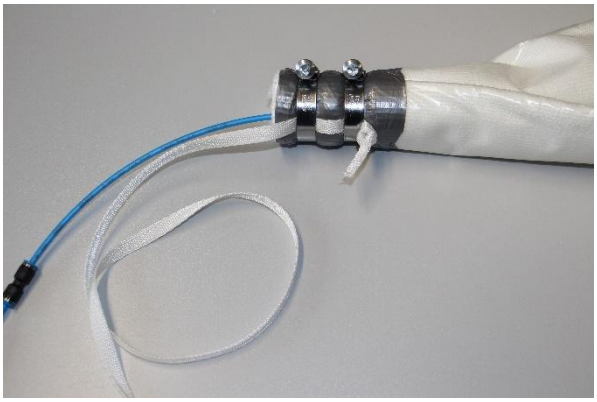


2. Place the right BRAWO® steam sleeve into the BRAWOLINER® and fold it around it in an S-shape.

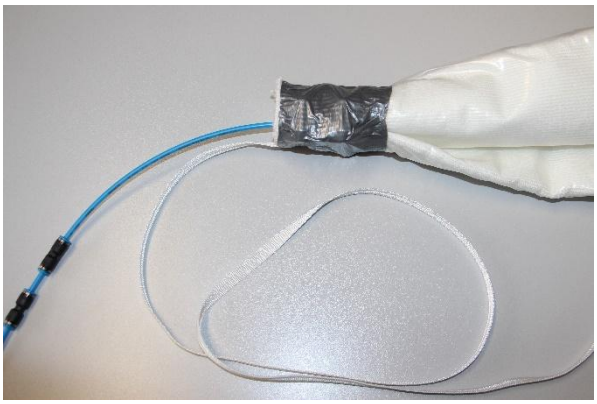
3. Cover the folded piece with adhesive tape.



4. Cover the folded piece with hose clips and tie the retaining strap in with it. Make sure that the hose clips are located in the grooves of the BRAWO® steam sleeve. Tighten the hose clamps evenly and tightly.



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



ATTENTION!

It is essential to ensure that the liner, the fabric adhesive tape and the end of the retaining strap do not protrude from the sleeve. A projection > 1 mm must be cut off flush with the end of the sleeve, otherwise the bore in the sleeve may become blocked.

NOTE!

The fastening of the retaining strap should be done up to DN 70 with cable ties, from diameter > DN 100 with hose clips.

4.8.0 Inversing the BRAWOLINER®

There are basically two methods available for inversing the BRAWOLINER®:

1. **Inversion process with BRAWO® inversion drum / Drum 4.0**
2. **Inversion process with BRAWO® tripod**

Both methods can be further subdivided with the following variants:

a) Installation with closed end
b) Installation with open end
c) Installation with BRAWO® steam sleeve in the BRAWOLINER® (only for the inversion process with BRAWO® inversion drum / Drum 4.0 and subsequent steam curing)

To accelerate the curing process, methods a) and b) can optionally be followed by **hot curing (water)**.
An accelerated **curing with steam** can be done when using the BRAWO® inversion drum / Drum 4.0 and the use of the BRAWO® steam sleeve in the end.

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.

4.8.1 Inversion of the BRAWOLINER® with BRAWO® inversion drum / Drum 4.0

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 again with a lubricant (e.g. detergent, vegetable oil, etc.). This increases the sliding properties of the BRAWOLINER® during inversion.**
- **Direction of installation: the arrow printed on the liner must always point towards the start of the rehabilitation (pipe start).**

- **When installing the BRAWOLINER® 3D with open end, it is particularly important to apply sufficient lubricant to the PU- film. This prevents "blocking" of the calibration hose, e.g. if there are dimension shifts.**

ATTENTION!

- **Retaining strap, any hoses and calibration hose must be already in the BRAWO® inversion drum / Drum 4.0 before winding the BRAWOLINER®!**
- **When using the BRAWO® steam sleeve in the liner end, ensure that the air supply volume of the compressor is greater than the volume of air escaping from the openings!**
- **With a sufficient amount of air available, the bore in the BRAWO® steam sleeve can be adjusted.**
- **The installation recommendations for inversion pressures from Page 27 are to be observed.**
- **In particular, the BRAWOLINER® 3D DN 200-300 and the BRAWOLINER® 3D DN 300-400 must be supported outside the pipe when installing with 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).

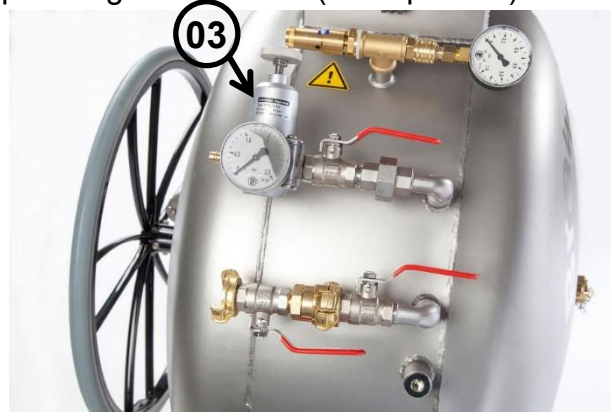
1. Wind the BRAWOLINER® onto the drum axle. The arrow on the surface of the wound liner must point away from the drum axle towards to the inversion connections.

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

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

4. Protect the rim from damage with fabric adhesive tape and fasten it to the inversion pipe with at least two hose clips.

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 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 (***see Page 34 and Page 27***).



7. The inversion speed can be adjusted at the pressure control valve (Pos. 03) and on the handwheel of the BRAWO® inversion drum / Drum 4.0.

8. Dependent on installation option:

8.1. Variant "Open end"

Inversion is complete when the BRAWOLINER® has reached the end of the rehabilitation section, the rubber ring flies off and the BRAWOLINER ® collapses. For more information about the subsequent process, see ***Chapter 4.9.1 "Inversion of the calibration hose with BRAWO® inversion drum"*** starting on ***Page 72***.

8.2. Variant "Closed end"

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 until completely cured. If possible, the curing pressure should be used for orientation depending on the liner type (**see page 2527**). Special local conditions may require different pressures (***see Page 34***).

The subsequent procedure is dependent on the variant:

- **Curing at ambient temperature**

  Comply with data regarding curing times at ambient temperature. See ***Chapter 3.3.4 "Resin types"*** on ***Page 24*** or technical data sheets for BRAWO® resins.
  The subsequent process is described from point 9 on ***Page 68***.

- **Hot curing (water)**

  See ***Chapter 4.10.0 "Hot curing (water)"*** starting from ***Page 79***.

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

When the end of the rehabilitation section is reached, the BRAWOLINER® releases the openings in the BRAWO® steam sleeve. A reduction in the inner pressure must be countered by increasing the air supply volume at the pressure control valve of the control unit.

For more information about this, see ***Chapter 4.11.0 "Hot curing (steam)"*** starting from ***Page 87***.

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

10. Open the hose clips on the inversion pipe.

11. Cut the BRAWOLINER® off flush with the old pipe. Smooth out any unevenness in the base area if necessary (e.g. with cement mortar).

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

12. Open any sealed inlet pipes with a suitable tool.

- The installation option you selected is now completed. –

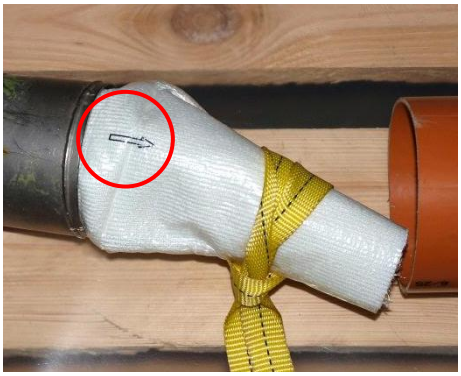
4.8.2 Inversion of the BRAWOLINER® using BRAWO® tripod

DANGER!

- **DANGER OF SCALDING due to hot water**
- **DANGER OF TIPPING OVER!**
  Always ensure the equipment is standing / attached securely.
- **DANGER OF FALLING when working on scaffolding or ladders.**

ATTENTION!

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



- **The inversion pressure should be set according to the liner type in accordance with the table on Page 27.**

1. **In case of hot curing (water), bear in mind:**

A sufficiently long water hose is connected to the closed end of the impregnated BRAWOLINER® (parallel to the retaining strap) in the "Closed end" variant.

In the "Open end" variant, the water hose is connected to the calibration hose and inversed.

Steam curing is not recommended in conjunction with the BRAWO® tripod.

2. With the help of the guide rope, pull the start of the BRAWOLINER® through the inversion hose and the corresponding inversion pipe.

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

4. Protect the rim from damage with fabric adhesive tape and fasten it to the inversion pipe with at least two hose clips.

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 starts to fill the inversion hose with water. Inversion generally occurs with a water column of 2 – 3 m (≙ 0.2 – 0.3 bar). Please take note of the recommendations for each liner type on **Page 27**. Special conditions on site may require different pressures (***see ATTENTION!*** on ***Page 34***).

7. The inversion speed can be controlled by the volume of water fed in and, where necessary, with the retaining strap.

8. Dependent on the option:

8.1. Variant "Open end"

When the BRAWOLINER® is halfway inversed, the end sealed with the rubber glove must be released. Inversion is complete when the BRAWOLINER® has reached the end of the rehabilitation section, the rubber ring flies off and the BRAWOLINER® collapses. For more information about the subsequent process, see ***Chapter 4.9.2 "Inversion of the calibration hose with BRAWO® tripod Inversion of the calibration hose with "*** starting on ***Page 76***.

8.2. Variant "Closed end"

Inversion is complete when the BRAWOLINER® has reached the end of the rehabilitation section. Fasten the retaining strap to the inversion frame. The BRAWOLINER® is cured with the recommended pressure for each liner type (**see Page 27**). Curing generally takes place with a water column of 3 - 4 m (≙0.3 - 0.4 bar). Special conditions on site may require different pressures (***see ATTENTION!*** on ***Page 74***).

The subsequent procedure is dependent on the variant:

- **Curing at ambient temperature:**

  Comply with data regarding curing times at ambient temperature. See ***Chapter 3.3.4 "Resin types"*** on ***Page 24*** or technical data sheets for BRAWO® resins.

  The subsequent working procedure is described from point 9 on ***Page 71***.

- **Hot curing (water):**

  See ***Chapter 4.10.0 "Hot curing"*** starting from ***Page 79***.

9. After complete curing, drain the water column, if necessary, pump it out.

10. Open the hose clips on the inversion pipe.

11. Cut the BRAWOLINER® off flush with the old pipe. Smooth out any unevenness in the base area if necessary (e.g. with cement mortar).

12. Open any sealed inlet pipes with a suitable tool.

- The installation option you selected is now completed. –

4.9.0 Inverting the calibration hose

There are basically two methods available for inversing the calibration hose:

1. **Inversion process with BRAWO® inversion drum / Drum 4.0**
2. **Inversion process with BRAWO® tripod**

To accelerate the curing process, both methods can then be followed by **hot curing (water)**.

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!

- **Holding back the calibration hose too early can restrict the circulation of water in case of hot curing (water).**
- **The inversion pressures should be set according to the recommendations on Page 27 and Page 34.**
- **The technical data for the calibration hoses used must be observed.**
- **In particular, for diameters >DN 225, the curing pressure must be limited in accordance with the specifications.**

1. After the rubber ring has flown off at the end of the "open end" inversion process, the BRAWOLINER® collapses.

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

3. Open the hose clips on the inversion pipe, loosen the BRAWOLINER® and secure against slipping.

4. 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.

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

6. Align the inversion pipe towards the pipe being rehabilitated (second operator).

7. The second operator gives the signal to start. The first operator then opens 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 conditions on site may require different pressures (***see ATTENTION! on Page 34 and page 27***).

8. The inversion speed can be influenced at the pressure control valve (pos. 03) and at the handwheel of the BRAWO® inversion drum.

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

ATTENTION!

- **Holding back the calibration hose too early - can restrict the circulation of water in case of hot curing (water).**
- **The curing pressures should be set according to the recommendations on Page 27 and Page 34.**
- **The technical data for the calibration hoses used must be observed.**
- **In particular, for diameters >DN 225, the curing pressure must be limited in accordance with 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 has cured. Special local conditions may require different pressures (*see ATTENTION!* on *Page 34*).
    The subsequent procedure is dependent on the variant:

    - **Curing at ambient temperature**

      Comply with data regarding curing times at ambient temperature. See *Chapter 3.3.4 "Resin types"* on *Page 24* or technical data sheets for BRAWO® resins.
      The subsequent working procedure is described from point 11 on *Page 74*.
    - **Hot curing (water)**

      See *Chapter 4.10.0 "Hot curing"* on *Page 79*.

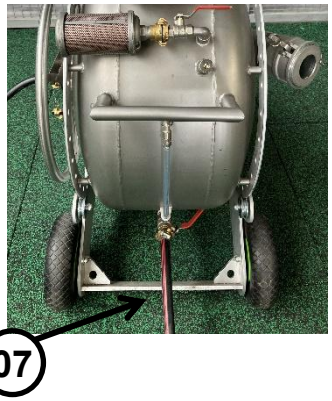
12. After curing is complete, pull the calibration hose under a low pressure (approx. 0.05 bar) out of the BRAWOLINER® by folding it back with the help of the retaining strap.

13. Vent the system pressure (open ball valve Pos. 05).

14. Open the hose clips on the inversion pipe

    and remove the calibration hose.

15. Cut the BRAWOLINER® off flush with the old pipe. Smooth out any unevenness in the base area if necessary (e.g. with cement mortar).



16. If there is water in the drum, open the ball valve Pos. 07 and drain.

17. Open any sealed inlet pipes with a suitable tool.

- The installation option you selected is now completed. –

4.9.2 Inversion of the calibration hose with BRAWO® tripod

DANGER!

- **DANGER OF SCALDING due to hot water**
- **DANGER OF TIPPING OVER!**
  Always ensure the equipment is standing / attached securely.
- **DANGER OF FALLING when working on scaffolding or ladders.**

ATTENTION!

If liner type BRAWOLINER® 3D has been inversed, the calibration hose must be thoroughly lubricated (also internally). Inverse the calibration hose slowly and with increased pressure (according to the table on Page 27). The diameter of the calibration hose must always correspond at least to that of the largest available pipe diameter.

- **The technical data for the calibration hoses used must be observed.**
- **In particular, for diameters >DN 225, the curing pressure must be limited in accordance with the specifications.**

1. After the rubber ring has flown off at the end of the "open end" inversion process, the BRAWOLINER® collapses.

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

3. With the help of the guide rope, pull the start of the calibration hose through the inversion hose and the inversion pipe.

4. Fold the start of the calibration hose over the inversion pipe, secure with fabric adhesive tape and clamp together with the previously inverted BRAWOLINER® using at least two hose clips.

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

6. The second operator gives the signal to start. The first operator then starts to fill the inversion hose with water. Inversion occurs with a water column of 2 – 3 m (≙ 0.2 – 0.3 bar). Special on-site conditions may require different pressures (see ATTENTION! on **Page 34** and **Page 27**).

7. The inversion speed can be controlled by the volume of water fed in and with the retaining strap.

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

ATTENTION!

- **Holding back the calibration hose too early can restrict the circulation of water in case of hot curing (water).**
- **The curing pressures should be set according to the recommendations on Page 27.**
- **The technical data for the calibration hoses used must be observed.**
- **In particular, for diameters >DN 225, the curing pressure must be limited in accordance with the specifications.**

9. Fasten the retaining strap to the inversion frame.

10. The pressure in the rehabilitation section must be maintained at 3 - 4 m water column (≙ 0.3 - 0.4 bar) until the resin has cured. Special local conditions may require different pressures (*see Page 34)*.

The subsequent procedure is dependent on the variant:

- **Curing at ambient temperature**

  Comply with data regarding curing times at ambient temperature. See ***Chapter 3.3.4 "Resin types"*** on ***Page 24*** or technical data sheets for BRAWO® resins.

  The subsequent working procedure is described from point 11 on ***Page 78***.

- **Hot curing (water)**

  See ***Chapter 4.10.0 "Hot curing (water)"*** starting from ***Page 79***.

11. After curing is complete, pull the calibration hose under a low pressure (about 0.5 m water column ≙ 0.05 bar) out of the BRAWOLINER® by folding it back with the help of the retaining strap. Where necessary, pump off any rise in the water column.

12. Open the hose clips on the inversion pipe and remove the calibration hose.

13. Cut the BRAWOLINER® off flush with the old pipe. Smooth out any unevenness in the base area if necessary (e.g. with cement mortar).

14. Open any sealed inlet pipes with a suitable tool.

- The installation option you selected is now completed. –

4.10.0 Hot curing (water)

in conjunction with quality seal S27.1

DANGER!

- **DANGER OF POISONING DUE TO EXHAUST FUMES!**
  Set the BRAWO® HotBox up outdoors or ensure that the exhaust fumes are suitably discharged to the outdoors.
- **DANGER OF FIRE!**
  Never cover the exhaust fumes chimney (Pos. A).

WARNING!

DANGER OF SCALDING
due to hot water or steam.

CAUTION!

DANGER OF BURNS
on the BRAWO® HotBox. Parts may become hot.

ATTENTION!

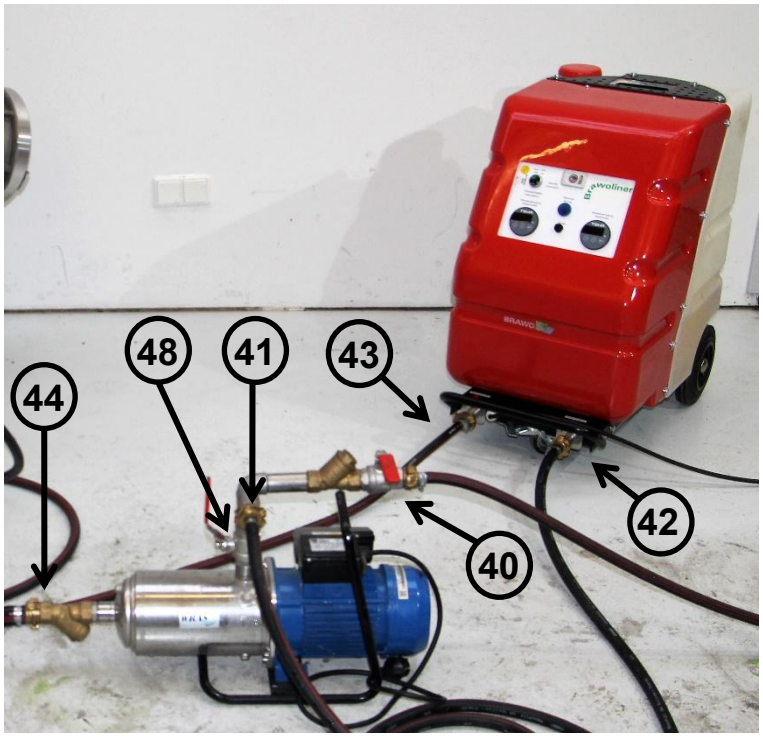
The necessary preconditions for using the BRAWO® Hotbox must be observed. The separate operating and maintenance instructions for the BRAWO® Hotbox must be complied with.

NOTE!

The BRAWO® HotBox is an oil-fired heater that heats the water during circulation.

General preparations:

1. Set up a water supply:
   a) From the water tap to the circulation pump (Pos. 40)
   b) From the circulation pump (Pos. 41) to the water inlet of the BRAWO® HotBox (Pos. 42)
   c) From the water outlet of the BRAWO® HotBox (Pos. 43) to the BRAWO® inversion drum (Pos. 02), or BRAWO® tripod (=***feed***).



2. Connect the suction hose with the suction connection (Pos. 44) of the circulation pump. Use the shortest possible length of hose. Connect the other end of the suction hose with the ball valve on the drum base (Pos. 07); on the BRAWO® tripod variant, the end of the suction hose must protrude sufficiently far into the BRAWO® tripod and must then be secured (= ***return***).

3. The subsequent procedure is dependent on the variant:

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

     The subsequent working procedure is described from point 4. on ***Page 82***.

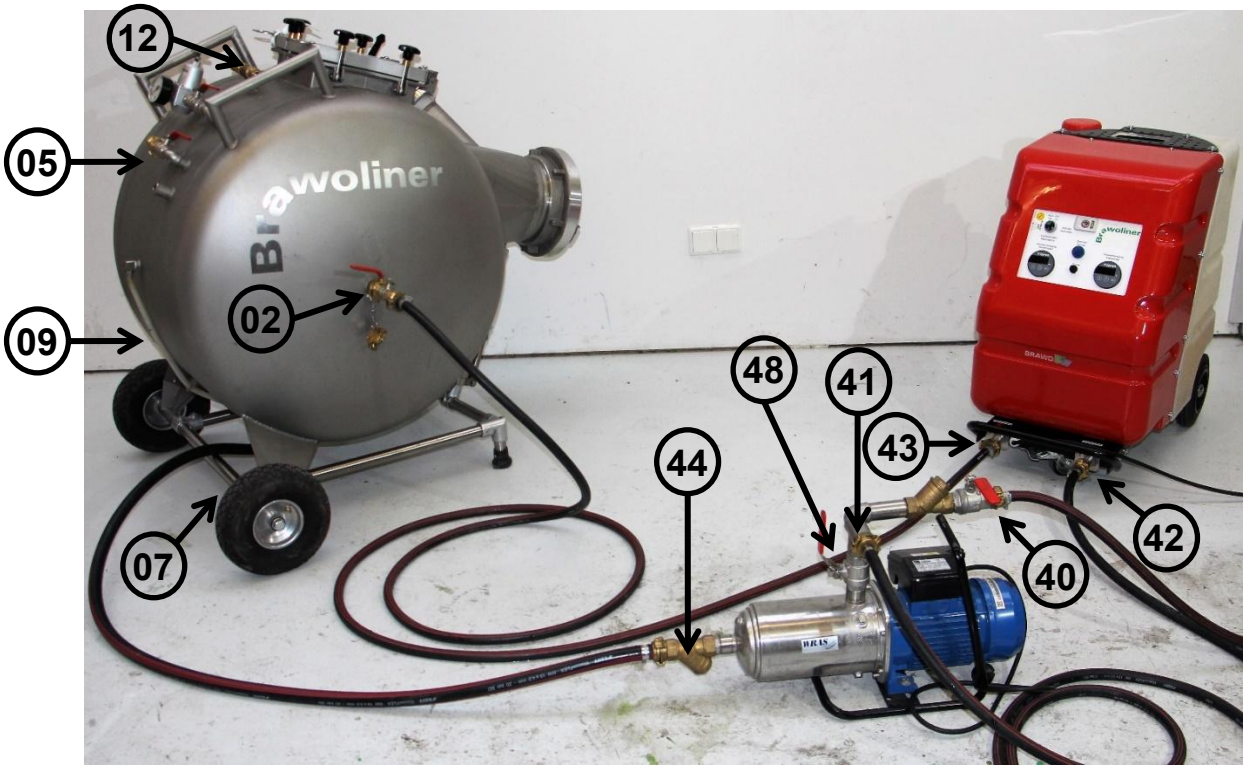
   - **BRAWO® tripod variant**

     Ensure that the required fill height is achieved for curing (generally 3 - 4 m). Close the ball valve (Pos. 40).

     The subsequent working procedure is described from point 7 on ***Page 82***.

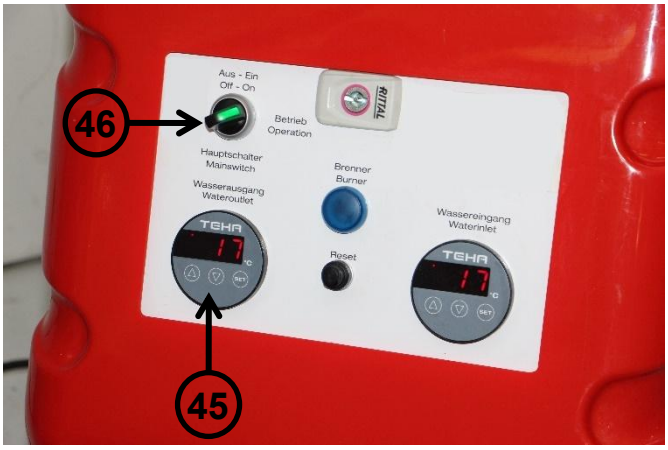
4. Fill in water: close the ball valve (Pos. 48), open the ball valve (Pos. 02), open the tap and the ball valve (Pos. 40) and let cold water run in until the BRAWO® inversion drum / Drum 4.0 is filled to about a quarter (water level display Pos. 09). The system pressure must be monitored during filling (Pos. 12), If it increased above 0.4 bar, vent some air (ball valve Pos. 05). The operating

pressure should be between 0.3 - 0.4 bar. Take not of the varying curing pressures depending on the liner type (**Page 27**). Local conditions may require different pressures (***see ATTENTION!*** on ***Page*** *Fehler! Textmarke nicht definiert.*).



5. Once the fill level is reached, close the ball valve (Pos. 40).
6. Open ball valve on drum base (Pos. 07).
7. Open ball valve for circulation (Pos. 48).
8. Ensure that there is no air in the circulation, vent if necessary. Then switch on the circulation pump.
9. Switch on the BRAWO® Hotbox (Pos. 46).
10. Set the recommended water temperature at the BRAWO® HotBox regulator (Pos. 45).

- **Up to 55 °C: when using BRAWOLINER®**
- **Up to 75 °C: when using BRAWOLINER® HT and / or temperature-stable calibration hose**



11. The system pressure will increase again while heating. If nec. Vent air or drain water. The curing pressure should be between 0.3 - 0.4 bar (≙ 3 - 4 m water column). Local conditions may require different pressures (***see ATTENTION!*** on ***Page 16***). ***Chapter 2.4.0 "Sources of danger - Accident prevention"*** on ***Page 8*** and the different installation instructions for the liner types used on ***Page 64, Page 27*** *and* ***Page 74***) must also be observed.

12. The return temperature must be checked (e.g. separate thermometer). After the return has reached the recommended temperature, the curing time begins.
The necessary **total heating duration** is composed as follows:

	Heating up time
+	**Curing time**
=	**Total heating duration**

NOTE!

The burner switches on once:

- **The BRAWO® HotBox is switched on**
- **Water is circulating**
- **The water temperature is below the set temperature**

NOTE!

Pay attention to information on the curing times of the BRAWO® resins during hot curing.
See *Chapter 3.3.4* "Resin types" on *Page 24* or technical data sheets for BRAWO® resins.

ATTENTION!

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

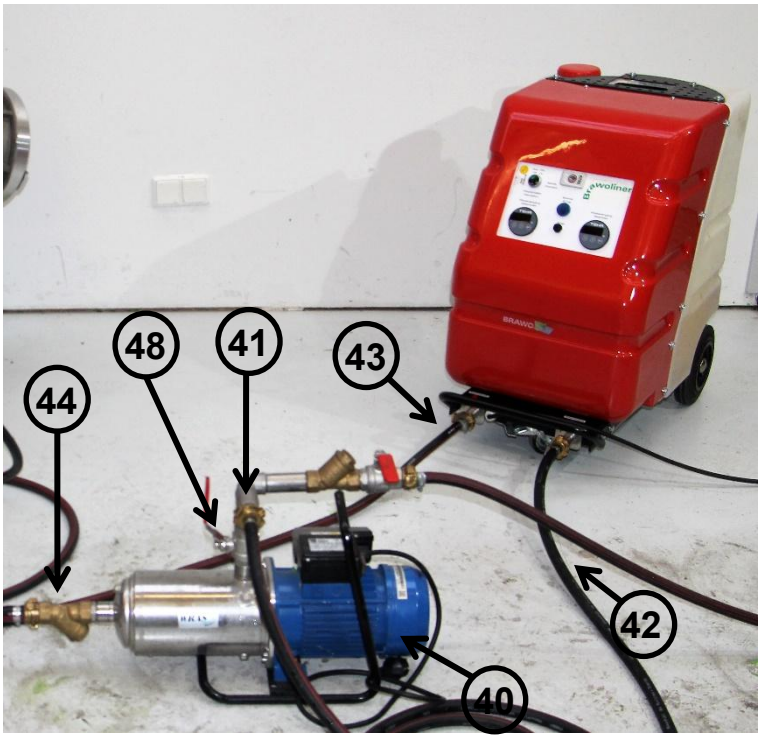
- **BRAWO® I:** **approx. 100 minutes at 50 °C**
  approx. 45 minutes at 70 °C
- **BRAWO® III / AC:** **approx. 220 minutes at 50 °C**
  approx. 140 minutes at 70 °C
- **BRAWO® HT:** **approx. 140 minutes at 50 °C**
  approx. 80 minutes at 70 °C

13. Once the curing time has elapsed, check the firmness of the inversed BRAWOLINER® (on the part that protrudes from the rehabilitated pipe). If the BRAWOLINER® can no longer be bent manually, the curing process is complete and the cooling process can be started.

ATTENTION!

Maintain a constant pressure during cooling.

14. Switch off the BRAWO® HotBox.



15. Remove the water hose from the water tap at Pos. 40 and connect it to the feed hose (which was connected to the water outlet of the BRAWO® Hotbox (Pos. 43)).

16. Reposition the return hose:

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

  From the valve in the drum base (Pos. 07), lay a water hose outdoors (CAUTION: Do not direct water onto the installed liner).

- **BRAWO® tripod variant**

  Remove the return hose at Pos. 42, extend it if necessary and lay it outdoors (CAUTION: Do not direct water onto the installed liner).

17. Open the water tap and allow cold water to run until the inversion pipe has cooled down. The pressure must remain constant here:

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

  Regulate it by opening the valve in the drum base (Pos. 07).

- **BRAWO® tripod variant**

  Pump off the rising water column.

18. After that, close the water supply.

19. Vent the system pressure:

- **"Closed end" BRAWOLINER® variant**

  If nec. open ball valve Pos. 05.
  At the end of the rehabilitation section, open the BRAWOLINER®, the water drains out. Undo and retrieve the water hose.

- **"Open end" BRAWOLINER® variant**

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

    a) Remove water hose from drum axle (Pos. 02).

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

    c) Retrieve the calibration hose and water hose with the hand wheel.

  - **BRAWO® tripod variant**

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

    b) After curing is complete, pull the calibration hose under a low pressure (about 0.5 m water column ≙ 0.05 bar) out of the BRAWOLINER® by folding it back with the help of the retaining strap. Where necessary, pump off any rise in the water column.

20. Open the hose clips on the inversion pipe.

21. Cut the BRAWOLINER® off flush with the old pipe. Smooth out any unevenness in the base area if necessary (e.g. with cement mortar).

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

23. Open any sealed inlet pipes with a suitable tool.

- The installation option you selected is now completed. –

4.11.0 Hot curing (steam)

in conjunction with quality seal S27.2

DANGER!

- **Comply with the information in the Health and Safety Act (BetrSichV, formerly the Ordinance on Steam Boilers)!**
- **DANGER OF POISONING DUE TO EXHAUST FUMES!**
  Set the BRAWO® SteamGenerator up outdoors or ensure that the exhaust fumes are suitably discharged to the outdoors.
- **DANGER OF FIRE!**
  Do not cover hot parts, never cover the exhaust fumes flue.
- **The steam generator may only be operated with filtered and softened water, which has also had an oxygen binder added to it!**
  - ⇨ **The use of untreated water will lead to limescale deposits (boiler scale) and corrosion!**
  - ⇨ **Non-compliance can lead to a loss of - function in the safety equipment (pressure relief valve, water cutout) and bursting of the steam boiler!**

WARNING!

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

CAUTION!

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

ATTENTION!

The necessary preconditions for using the BRAWO® SteamGenerator must be observed. The separate operating and maintenance instructions for the BRAWO® SteamGenerator must be complied with.

NOTE!

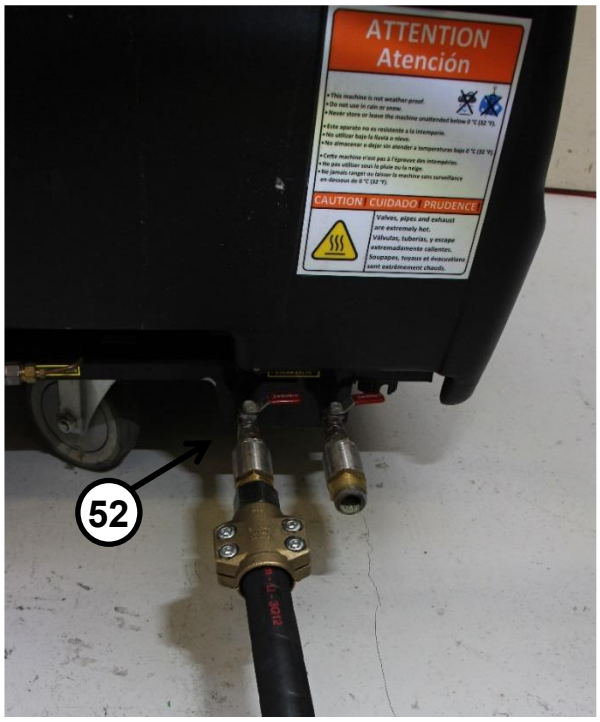
- **The BRAWO® SteamGenerator is a high-speed steam generator fuelled by heating oil or diesel with a steam boiler used as buffer storage.**
- **The steam generator has a heating time of approx. 10 - 15 minutes.**
- **The following steps 1 to 8 should be implemented before or in parallel with the inversion process.**
- **With BRAWO® SRR there is a risk of extreme temperature development as a result of the exothermic resin reaction when curing with steam. Curing with steam is therefore not recommended.**

1. Place the steam generator and BRAWO® Control on a suitable horizontal surface without danger of tipping and lock the brakes on the rollers.

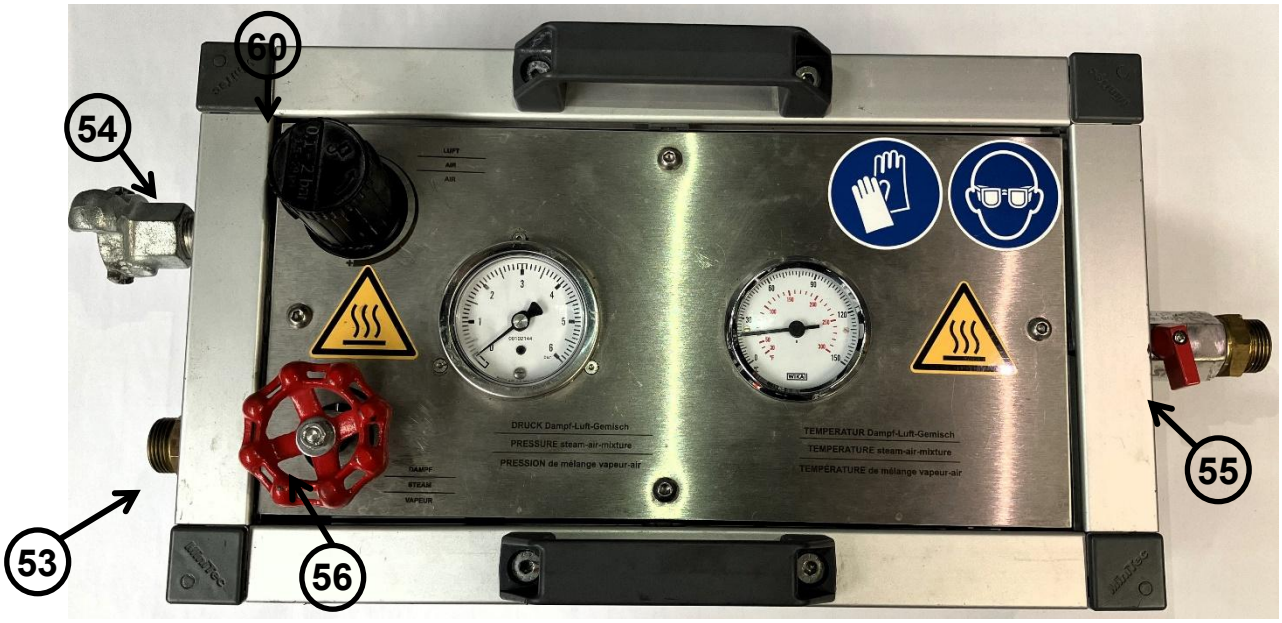
2. Set up the hose connections:

   a) Drinking water tap → steam generator water inlet (Pos. 51)

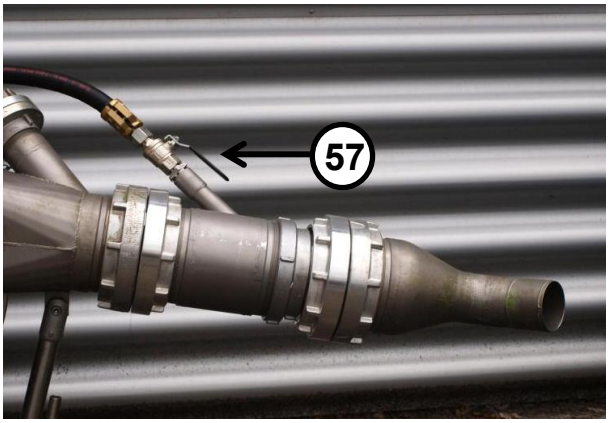
   b) Steam outlet valve (Pos. 52) → BRAWO® Control steam inlet (Pos. 53)

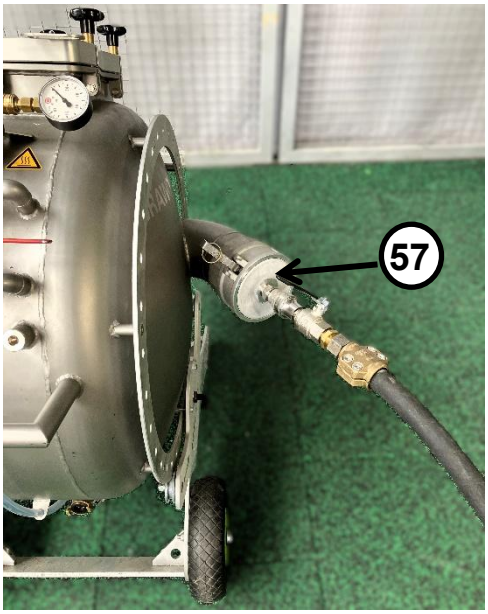


   c) Compressor → BRAWO® Control air inlet (Pos. 54)



d) BRAWO® Control outlet valve (Pos. 55) → Steam inlet on the adapter (Pos. 57).





3. Make sure that the ball valve at 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 turn on the electricity 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 stops.

NOTE!

- **The steam temperature and steam boiler pressure are directly linked.**
- **In order to mix steam with the flowing air, the steam pressure must always be higher than the air pressure set at the regulating unit.**

5. Open steam inlet at the adapter (Pos. 57).
6. Set the amount of air at the BRAWO® Control pressure control valve (Pos. 60). Close the air supply at the inversion drum (Pos. 03).
7. Dose the volume of steam into the flowing air at the steam control valve (Pos. 56).

NOTE!

- **When using the BRAWO® steam sleeve, the internal pressure of the liner / calibration hose must be regulated by the quantity of the incoming steam-air mixture and kept constant in accordance with the recommendations on Page 27 and Page 34.**
- **The temperature of the steam-air mixture must be regulated to approx. 80 °C at the steam inlet of the inversion equipment.**
- **The maximum temperature capacity of the old pipe must be observed!**
- **The maximum temperature resistance of the calibration hose must be observed!**

8. Set the pressure in the BRAWO® inversion drum / Drum 4.0 and the temperature at the steam inlet by readjusting at the air control valve (Pos. 60) or steam control valve (Pos. 56) to the setpoints mentioned above.

9. The necessary **total heating duration** is composed as follows:

	Heating up time
+	**Curing time**
=	**Total heating duration**

ATTENTION!

HEATING TIME:
Depends on the length and the ambient conditions of the rehabilitation section as well as on the diameter of the inversed BRAWOLINER® HT.

It is recommended that the actual temperature present between the liner and the old pipe is measured.

ATTENTION!

CURING TIME:
The curing time only starts once the opposite end (from the steam inlet) of the BRAWOLINER® HT has reached the recommended temperature (= heating up time)

- **BRAWO® I:** **approx. 100 minutes at 50 °C**
  approx. 45 minutes at 70 °C
- **BRAWO® III:** **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

NOTE!

Pay attention to information on the curing times of the BRAWO® resins during hot curing.
See *Chapter 3.3.4 "Resin types"* on *Page 24* or technical data sheets for BRAWO® resins.

10. After the total heating duration has elapsed, check the firmness of the inversed BRAWOLINER ® HT (on the part that protrudes out of the rehabilitated pipe). If the BRAWOLINER® HT can no longer be bent manually, the curing process is complete and the cooling process can be started.

11. Switch off the steam generator and close the steam outlet valve (Pos. 52).

12. The air flow volume (or internal pressure) can be increased for faster cooling at 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 internal pressure can be released.

13. Dependent on the option:

    - **"BRAWO® steam sleeve in the BRAWOLINER® HT“ variant**

      At the end of the rehabilitation section, open the BRAWOLINER® HT, remove the BRAWO® steam sleeve and retract the retaining strap.

    - **"BRAWO® steam sleeve in the calibration hose" variant**

      Pull the calibration hose under a slight pressure (approx. 0.05 bar) out of the BRAWOLINER® by folding it back.

14. Open the hose clips on the inversion pipe.

15. Cut the BRAWOLINER® off flush with the old pipe. Smooth out any unevenness in the base area if necessary (e.g. with cement mortar).

16. Open any sealed inlet pipes with a suitable tool.

- The installation option 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 Troubleshooting

Please refer to the respective operating instructions for the individual machines and devices.

7.0.0 Important information about reaction resins

The epoxy resins used are so-called reaction resins.

7.1.0 What are reaction resins?

Reaction resins usually consist of 2 components and are mixed and processed in a liquid state at the installation 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.

7.2.0 Influence of temperature on the pot life

After mixing the components, the chemical reaction begins (= curing time). The pot life is an indication of the respective processing and curing times of the epoxy resins.

The pot lives stated here are values measured under laboratory conditions, calculated using mixtures weighing 100 g.
The higher the ambient temperature, or the greater the amount of resin that is mixed, the faster the chemical reaction takes place (= curing). This means that the theoretical processing time and curing time is greatly reduced with increasing resin quantity.

General rule:

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

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

7.3.0 Manufacturing instructions

NOTE!

Comply with the technical data sheets of the corresponding resins.

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

ATTENTION!

- **The mixing proportions must be complied with!**
- **Any change in the quantity of hardener will not have an effect on the curing speed, but will lead to a deterioration of the material properties.**

Storage:

Storage must be frost-free; the ideal storage temperatures are between +5 °C and +30 °C.

Processing:

The processing time for the resin mixtures is influenced by:

- **The processing temperature**

  Warm / cool the components before processing to between +13 °C and +15 °C. We recommend storage in a climate-controlled cabinet to achieve the correct temperature.

ATTENTION!

Always check and record the resin temperature before processing.

- **The batch size:**

  Keep the batch size small (do not mix entire containers).

- **The mixing time:**

  The mixing time should be 3 minutes. Work with slow-rotating stirrers, such as the double-shaft BEBA mixer.

ATTENTION!

- **When mixing, scrape the floor and side walls of the resin container with the stirrer.**
- **Always make sure that no air is stirred in during the mixing process.**

- **The ambient temperature:**

  Work in the shade if ambient temperatures are high and do not leave any containers standing in the sun. The temperature in the duct must also be taken into account for cold curing.

To determine the required resin quantities, see ***Chapter 7.5.0 "Resin"*** on ***Page 101***.

7.4.0 Effect of the curing temperature on the resin properties

In general, the following applies up to a certain limit:

NOTE!

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

E--modulus, creep behaviour, thermal dimensional stability and chemical resistance can thus be improved.

A subsequent tempering step (heating after the curing process has been completed) also improves the properties.

ATTENTION!

- **In the case of resin build-up - especially with BRAWO® SRR and BRAWO® I - very high reaction temperatures arise in the resin.**
- **Especially in the case of steam curing, these temperature peaks cannot be dissipated.**
- **We recommend curing these resins at a moderate temperature or curing with hot water.**
- **A curing temperature > 70°C should be avoided.**

7.5.0 BRAWOLINER® resin consumption

BRAWOLINER® / BRAWOLINER® HT

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

BRAWOLINER® 3D / BRAWOLINER® HT 3D

DN	to achieve min. 3 mm wall thickness			reduced wall thickness *) min. 2 mm	
	roller spacing	BRAWO® I BRAWO® III BRAWO® SRR in kg/m	BRAWO® HT in kg/m	roller spacing	BRAWO® HT in kg/m
70-100	10.0 mm	0.9	1.1	7.0 mm	0.7
100-150	12.0 mm	1.5	1.8	10.0 mm	1.4
150-225		2.3	2.7		2.2

*) In order to prevent excessive resin build-up in inlets on small diameters especially in downpipes (DN40-DN70), it is recommended to impregnate the liner with a reduced roller spacing and a reduced amount of resin

.

BRAWOLINER® 3D DN 200-300

DN	to achieve min. 4,7 mm wall thickness	
	roller spacing	BRAWO® I BRAWO® III in kg/m
200-300	14.0 mm	4.1

BRAWOLINER® 3D DN 300-400

DN	to achieve min. 5,1 mm wall thickness	
	roller spacing	BRAWO® III in kg/m
300-400	15.5 mm	7.1

BRAWOLINER® XT

DN	to achieve min. 4 mm wall thickness		
	roller spacing	BRAWO® I BRAWO® III BRAWO® SRR in kg/m	BRAWO® HT in kg/m
150	11.0 mm	2.3	2.8
200		3.1	3.7

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

8.0.0 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®

version: 04/2026

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

objekt

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 ☐ BRAWOLINER® connection collar

☐ HT variante ☐ other

dimension | batch no.

resin resin selection BRAWO®

☐ I ☐ III ☐ HT ☐ SRR

batch no. component A:

batch no. component B:

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

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

impregnation ☐ on-site ☐ pre-impregnated

resin storage temperature [°C	target 5-30 °C		resin total target [kg]
resin temperature before installation [°C]	target 13-15 °C		resin total [kg]
mixing ratio [A:B]			actual resin quantity comp. A [kg]
Mixing time [min]	target 3 min		actual resin quantity comp. A [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

inversion with water column [m] target 2-3 m

curing conditions

☐ hot water ☐ hot steam ☐ cold

processing time liner at 15 °C		mixing start	installation time
BRAWO® I	approx. 50 min		
BRAWO® III	approx. 3,5 h		
BRAWO® SRR	approx. 30 min		
BRAWO® HT	approx. 70 min (20 °C)		

	curing time target		
temperature	at 70 °C	at 50 °C	at 10 °C
BRAWO® I	☐ approx. 45 min	☐ approx. 100 min	☐ approx.13 h
BRAWO® III	☐ approx.140 min	☐ approx. 220 min	☐ approx. 24 h
BRAWO® SRR	☐	☐ approx. 30 min	☐ approx. 2 h (20°C)
BRAWO® HT	☐ approx. 80 min	☐ approx. 170 min	☐ approx.13 h(15°C)

curing time [actual]

actual curing temperature [°C]

curing pressure [bar] target 0.3-0.4 bar

curing by water column [m] target 3-4 m

sketch and comments