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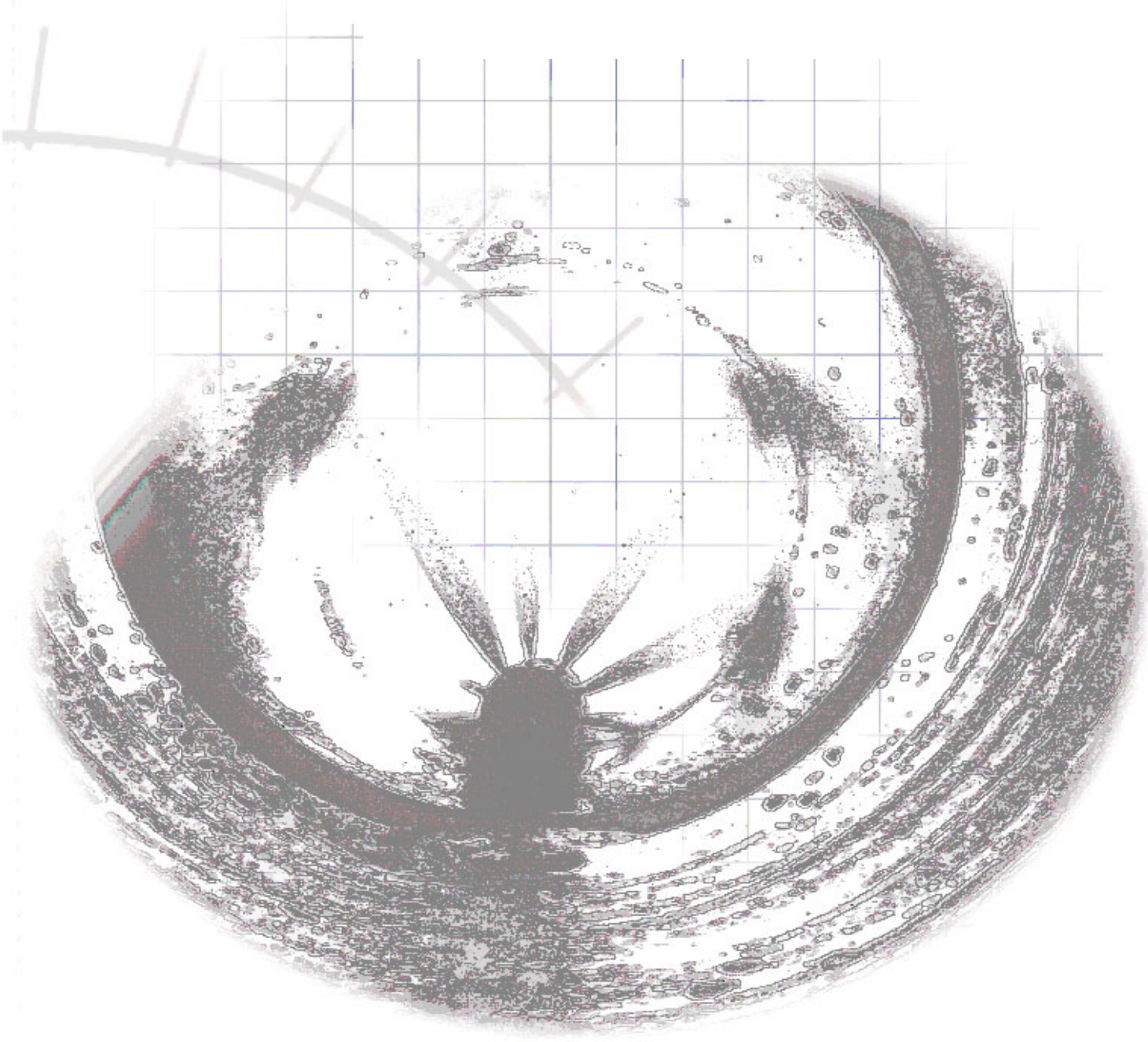
Handbook
Spot Repair System



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6. Annex (Band 2)

Annex (6.1.1 – 6.4.3) available on request.

0. General description

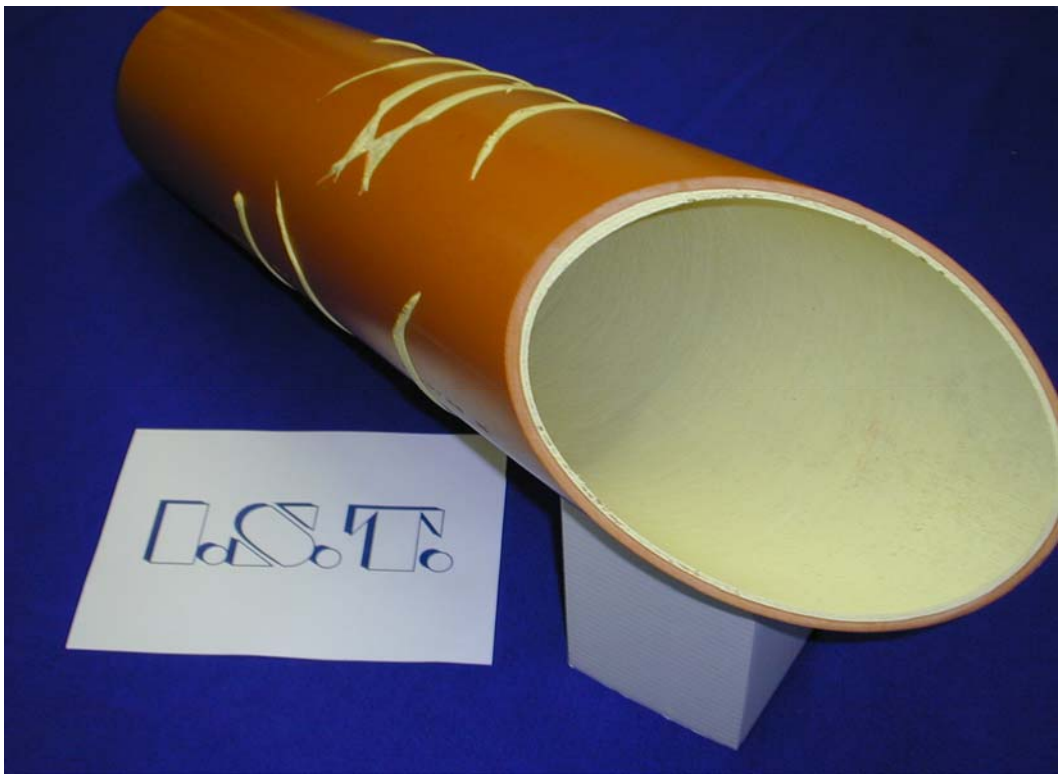
The EasyPur Spot Repair System is a process that quickly and without the use of expensive tools, is capable of sealing leakages caused by ex- or infiltration as well as the renewal of the burdening strength in the damaged carrier pipe.

At the impaired position, a pipe support system composed of a mechanical and chemical resistant composite material made up of fibre glass and silicate isocyanate resin is combined with the existing carrier pipe.

The quality of the EasyPur Spot Repair System and the items found in this handbook describing work practises are found within the following criteria;

- The Quality Protection Canal construction (Assessment group S15.18 Spot Repair System)
- the RSV-leaflet 4 and
- the ATV guideline M 143.

Prior to work commencing a warranty period of generally five years is agreed upon between client and contractor.



Process description

The EasyPur Spot Repair System is a localised repair system for the no dig repair of individual damaged areas in non-pressurised conduit type sewers and pipe lines.

Basis for the interpretation of the repair work is a video documentation of the damaged pipe section, from the type and position of the damage and the required length of repair.

The procedure involves the following steps:
The silicate isocyanate resin EasyPur is made up of the following components; A (white, hardener), B (black, isocyanate component resin) and C (beige, catalyst) and mixed in doses according to the instructions. A suitable fibre glass mat is then cut to fit the damaged area from a roll of Advantex® fibre glass and is soaked with the fluid resin mix. This is then placed onto a packer that fits the required pipe measurements and with aid of a camera placed at the damaged position within the pipe. The positioning of the packer can be achieved through various methods; using push rods, pneumatic push rods or a winch line. Once in position, the packer is inflated pressing the fibre glass mat onto the walls of the carrier pipe.

Thereby EasyPur presses into existing fissures; it has become a pasty consistence in the pipe joints, cracks and in between broken pieces and after curing manages a long time bonding with the carrier pipe. Therefore it is not only an adhesion with the surface of the carrier pipe but a form closure with the broken structure too!

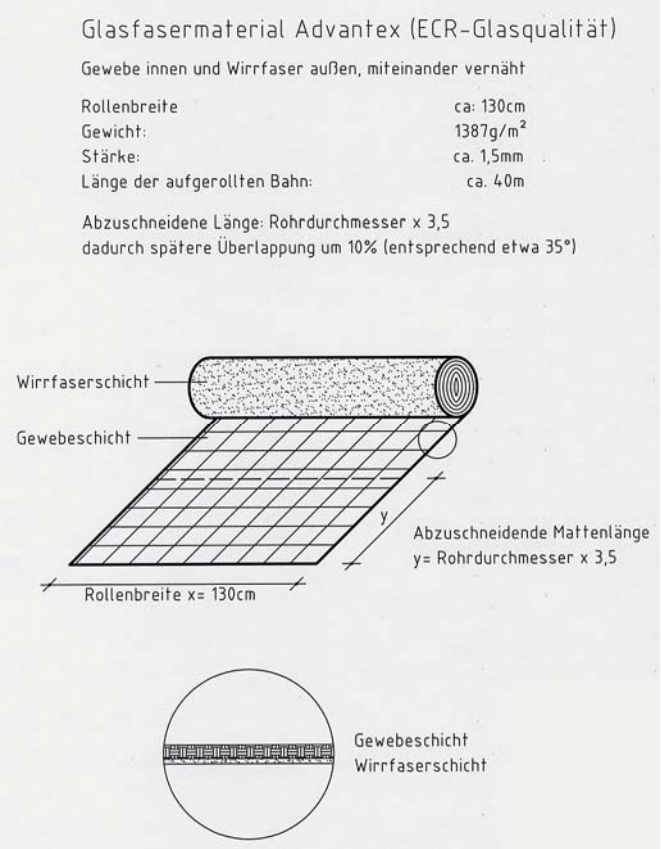
After curing of the EasyPur resin, which can occur after approximately 60 minutes, the packer can be deflated and drawn back. The length of time before the packer can be removed is dependant upon the varying temperatures of the substrate as well as the surface conditions or if standing ground water infiltrates. Through appropriate dosing of the C component though, all these can be compensated into the curing time. The given details are taken from laboratory values.

For the required structural analysis and the sealing ability, a minimum coating thickness of 3 mm is a requirement. We advise, due to the better mechanical properties, 4 mm in a DN 300 or upwards. So, EasyPur reduces the carrier pipe line diameter, by a minimum. As soon as the removal of the packer has taken place, the flow of fluids can immediately resume through the newly installed SpotLiner.
The survey of the localised repair is carried out with the aid of a CCTV and a video is documented. In association, a complete documentation of the repair course including all relevant details of materials used.
Seven days after the installation, the section is stable enough to receive a high pressure flush. (see Annex 6.2.1).

1. Properties of the liner

2.1 The fibre glass mat

The fibre glass matting gives the Spotliner a strengthening property, the necessary tensile strength and the higher E-modulus. The fibre glass alone exists from Advantex ECR glass, a boron free special fibre that holds a special resistance and possesses good mechanical properties. The special simplicity of the fibres guarantees a particular good bondage between fibres and resin.



The mats are made up of three layers, of those, two are woven set at a 90° angle to each other and the third is a tangled fibre layer. Through the resin soaked tangled fibres is the contact between mat and pipe or canal interior produced. In agreement with each client requirement, the fibre glass matting can be installed in two or three layer form. Remembering the fibre glass matting are also of various area weight specifications. The RSV leaflet writes a minimum thickness of the liner to be of 3 mm. In the here attached test reports (see Annex 6.2) fibre glass mats of 1387g/m² area weight in two ply form were used. A data sheet for these mats can be found in Annex 6.1.1.

2.2 The resin system

EasyPur is a specially developed resin for Spotliner rehabilitation of damaged carrier pipes, on a silicate isocyanate base.
It adheres superbly, also onto moist surfaces. It is also resistant against aggressive waters and does not foam. EasyPur excels through its outstanding adhesion properties and a very even and homogeneous surface in its final cured state. Pot and curing times can be adjusted through optimal doses of the component C whilst at the site.

Therefore, you can adjust EasyPur quickly and simply whether you have to set an EasyPur Spotliner at the beginning of the carrier pipe or into a larger dimension. The opposite would be if you were positioning a liner a little further into the carrier pipe and more process time was required. Less measures of component C added allows you this extra time. Whilst remembering not to forget the ambient temperatures and substrate conditions which could also affect your successful rehabilitation. With EasyPur, you can work with an extraction of the packer within 60 minutes in winter just as well as in summer. The data sheet can be found in Annex 6.1.2 – 6.1.5.

2.3 Properties of the finished product

The used technical relevant nominal values of the cured EasyPur Spotliner are to be found in the following material test listings;

- Material Test: (Annex 6.2.1)
  - Testing the adhesion capabilities in a stone ware pipe in accordance with DIN EN ISO 53 769- 3, or rather in accordance with DIN EN ISO 527- 4
  - Testing of the bending tensile and investigation of the bend E-modulus in accordance with DIN EN ISO 178
  - Water tightness in accordance with DIN EN 1610
  - Testing the chemical suitability in accordance with DIN EN ISO 175
  - Testing of the tensile strength and ultimate strain after EN ISO 527-4
  - Testing of the ring flexural strength, the circumference E-modulus and the ring stiffness in short term trials after DIN EN 1228 (DIN 53 769,Teil 3)
  - Regulation of heat loss after DIN EN 1172
- Drinking water and ground water hygiene tests (Annex 6.2.2)
- Demands through high powered flushing (Hamburg flush trials) (Annex 6.2.3)

3. Preconditions for the EasyPur Spot Repair System

Basis for the interpretation of repair work is a video documentation of the damaged carrier pipe section. This is then the decisive factor as to the art and position of the damage and the length of repair necessary.

3.1 Detailed cases

Through the following damage scenarios, the use of EasyPur Spot Repair System recommends itself:

- Leakages, for example through ex- or infiltration at lateral connections and cross-over between two different size dimensions, on pipe sleeves and with pipe bursts.
- Location tolerance, crack and broken parts accumulation
- Removal treatment of infiltrating roots
- No longer required or out of service connections, can be permanently sealed.

Pipe lines in round or oval form constructed of concrete, steel concrete, fibre cement and plastics in certain sizes are the most suitable for this repair (free flow and pressure pipes).

The EasyPur Spot Repair-System is exercised in mainly pipe dimensions of DN 100 – DN 500 of circular profile and 250/375 to 500/750 in oval profile at repair lengths of a maximum of 3 metres.

A precondition for a repair using this method is that the existing carrier pipes system base remains able to bear weight, also after the preparations for example through milling of projections.
Pipe bends, pipe misalignment, pipe breakage, also with impending cave in, as well as fissures and broken pieces with no longer the correct canal pipe bed fulfilment in general are not the preconditions for repair with the EasyPur Spot Repair System.

3.2 Preconditioning work

The dimensions of the pipe line must be checked. During the preparatory measures all blockages such as protruding objects, solidified sediment and sharp intrusions must be rectified. This is normally done through milling with a suitable milling robot. The pulling or pushing and the resulting inflation of the packer must not be affected.

Prior to repair, the damaged area is fundamentally to be cleansed using high pressure flushing or alternatively with a mechanical appliance. The complete pipe lines, as well as existing side inlets are to be kept free from flow through. The damaged area must be clean, free from faeces and where necessary, prior prepared. Therefore, suitable packers are to be placed and not removed until all working practices are completed. (Exceptions see Annex 4.2.4).

3.3 Accident prevention regulations, site security.

The surface area of the working site is to be secured according to StVO and GUV prior to work commencing. Inspection shafts and canal pipe lines must be controlled for dangerous gas concentrations before being entered. The equipment of the service vehicle should also include a functional gas warning device for this purpose alone. It should be carried at all times and service intervals, according to the manufacturer, should be observed.

The service personnel are responsible for their own personal safety equipment as laid down by legislation and working within the safety regulations whilst using the materials described in this handbook. The leaflet and working sheets from VDE and UVV as well as ATV-DVWK are to be acknowledged and applied.

4. Repair description

4.1 Preparations

Prior to commencing, it is advisable to check whether the requirements in annex 6.3.1. regarding materials, are readily available on site and under point 3, regarding preparations, have been carried out properly.

4.1.1 Packer

Appropriate packers are prepared for each of the canal pipe dimensions. For oval profile a special packer is also available. The packers must be fitted at either end with a minimum of two wheels set at an angle of 120° to one another. This reduces all contact of the resin soaked fibre glass mat, prior to inflation of the packer onto the carrier pipe wall (exception: DN 100 – 150 fitted with rails). Prior to use, packer, compressor and the technical devices for monitoring air pressure must be checked for correct functionality.

4.1.2 Fibre glass matting / size calculation

The EasyPur Spotliner is measured so that the damaged area and an extra 30 cm on both sides are covered. In the circumferal direction, this requires to be an increase of 10 % of the pipe circumference, although a minimum of 10 cm must overlap.As a guideline use:

The rule of thumb:

Area [m²] = DN 100 – DN 250:
(Pipe-Diameter [m] **x** 3.14) **+** 0.10 m
x Length of the Short liners [m]
x Number of layers

Area [m²] = DN 300 – DN 500:
(Pipe-Diameter [m] **x** 3.50)
x Length of the Short liners [m]
x Number of layers

The used amount of resin is dependant on the fibre glass type and resin temperature. Fibre glass mat 1086 g/m² = 1.6 litre per m², 1387 g/m² = 1.9 litre per m².
To become a layer thickness of minimum of 3mm of the EasyPur Spotliner, it is necessary to use a fibre glass mat of 1387 g/m² folded double, or a 1086 g/m² mat in three layers. Other requirements can be agreed upon. Should cutting be required, this must be carried out using a suitable pair of fibre glass scissors.

4.1.3 EasyPur resin system

4.1.3.1 Components A-B-C

The temperature of the resin components during the working process require to be between 15 °C and 25 °C, primarily between 15 °C und 20 °C. Through targeted dosages of the C component, you can allow the EasyPur system to be adjusted to the recommended requirements regarding temperatures inside the carrier pipe, the length of the Spotliner and the required inversion time. Recommendations for a standard example can be found in Annex 6.3.2. With liners, which require a longer inversion time, the amount of C component be appropriately reduced. With a shorter inversion time a quicker adjustment can be chosen.

The amount of resin made up for the soaking of the fibre glass mat, weighs approximately twice that of the matting itself. Guide values can be found in the Annexes 6.3.3 (two layers) and 6.3.4 (three layered). When irregular surfaces (eroded concrete pipes, larger fissures or similar.) it could be advised to use a little more resin.

The C component is to be shaken or stirred before use and in an appropriate amount mixed into the component A. This mixture is created using a mixing utensil such as a drill with a whisk attachment or something similar. This is then intensively mixed with the doubled volume of component B for at least two minutes until a single, streak free colour is recognised.

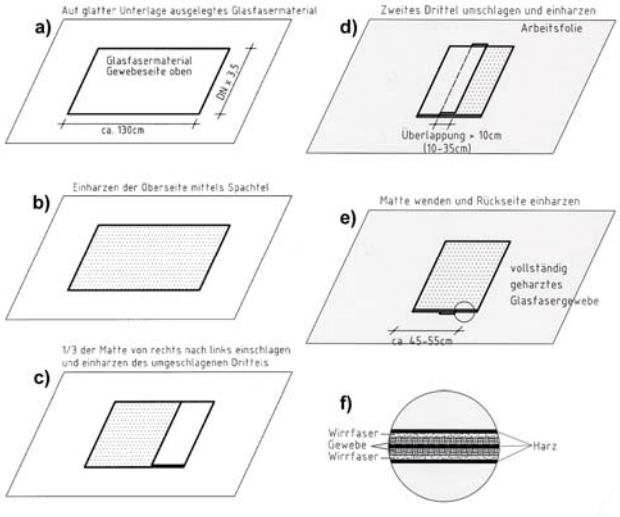
4.1.3.2 Component A-B in PE-bottles

The temperature of the resin components during the working process require to be between 15 °C and 25 °C, ideally between 15 °C und 20 °C. EasyPur in bottles is a pre-prepared system with a 3 % addition of the component C into the A component. The relevant process times can be read in Annexes 6.1.2 and 6.3.2. With liners that require longer or shorter inversion times, components A, B and C should be individually mixed according to requirements.

The bottles can be chosen because of its weight in relation to the fibre glass mat weight. The resin must weigh approximately double that of the prepared mat. Guide values can be found in Annexes 6.3.3 (two layers) and 6.3.4 (three layers). When irregular surfaces (eroded concrete pipe, larger fissures or similar.) it could be advised to use a little more resin.

The mixing ratio of the bottles with the components A and B is coordinated.
Both components are to be merged in the bigger bottle and mixed for approximately two minutes in order to complete a homogeneous mixture.

4.2 Soaking, folding and applying the fibre glass mat



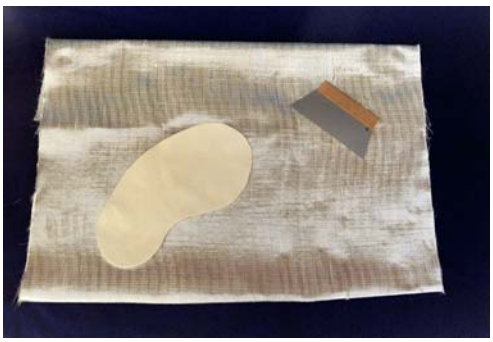
For soaking and folding the mat, it is advisable to use an even surface, possibly a table.

The following description is of a double layered spotliner with a length of 50 cm:

a) Sheeting is placed over the table which is larger than the fibre glass mat. The fibre glass mat of 130cm length (nominal roll length) and a width equal to three and a half times the pipe circumference is laid on the sheeting with the woven side facing up.

b) Approximately half of the resin mix is brought onto the matting and using a spatula or a rubber wipe, evenly spread.

c) One third of the mat (approx. 40 cm) is then folded over and also covered with resin



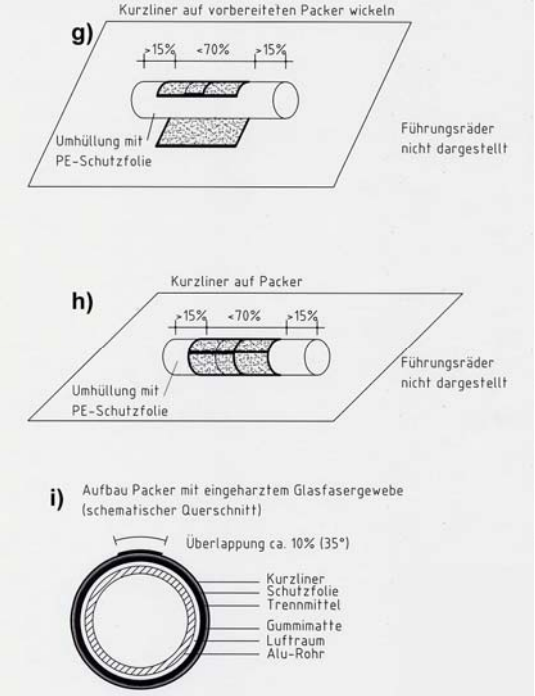
d) The other end of the mat is then also folded over and coated. The two ends need to overlap by approx. 20 cm

e) Afterwards, the complete matting is turned over to reveal the underside. This is then also covered with resin. Hereby, it is to an advantage to use a small roller to spread the resin evenly.

f) The tangled fibre side now lies on the outside. The overlap of the two sides is underneath.

When placing a three layered Spotliner, between phase b) and c) a further piece of fibre glass matting, in accordance with the above mentioned measurements, 50 cm long and of equal width, is laid onto the completely soaked matting and also soaked with resin. Here it is important to note which side is facing upwards. The remaining resin is now to be used completely. Making sure the mat edges are also fully

soaked.
The measurements for other diameters and lengths as well as the required resin can be found in Annexes 6.3.3 (two layers) and 6.3.4 (three layers) for irregular surfaces (eroded concrete pipes, larger fissures or even infiltration) is the resin amount, duly to be increased.



Applying the soaked fibre glass mat

To prepare the packer, it is sprayed with a release agent and wrapped with a plastic foil in the length of the packer and the width measuring, three and a half times the pipe diameter.

g) The packer is then laid onto the soaked mat with its axis at 90° to the overlapping seam created during folding. The mat is then tightly applied to the packer.
h) Loose fibres are smoothed down where necessary and smeared with resin.
i) Through application, a further overlapping along the longer side of approximately 35° is created.

Outside is the tangled fibre layer clearly visible, this is important for a good bonding to the carrier pipe. Simultaneously, the other tangled fibre layer is facing the packer. This is important for a smooth moulding and a good resistance to high pressure flushing.

4.3 Positioning of the packer in the pipe

When positioning the fibre glass mat in the pipe it is optimal when the overlapped end is positioned towards one of the side walls of the carrier pipe.
During the pulling or pushing to position the packer, it is important that the packer makes a minimum of contact with the pipe walls until at the area, where the carrier pipe is to be repaired.
Within the given process time, the packer is to be positioned at the damaged area and inflated. The advised inversion times must be adhered to, this also means the packer may not be inflated too soon! According to the chosen setting time of the component C, the packer must remain inflated at 1-2 bar in this position (see Annex 6.3.2) for 50-90 minutes. After complete curing of the soaked fibre glass material, the packer is deflated and with the aid of the guide rope, it is pulled from the pipeline.

Tip: The continuation of the flow through is made possible by using a bypass packer during the curing. If a packer is used without this option, a suitable stoppage of flow through must be enforced.

4.4 Inspection of the EasyPur Spotliner repair

The survey of the repaired section is carried out with the use of a closed circuit TV camera. This is run through with a running metre counter. Entrance and exit of the liner section are recorded separately and finally, a total recording is made of the entire length of the repaired section.

In the framework of every self control, a protocol is drawn up for every EasyPur spot liner repair. (Annex 6.4.1).

5. Self control and documentation

5.1 Materials

The components used during the process of the EasyPur Spot Repair System underlie the DIN EN ISO 9001 certified quality assurance of the manufacturing factory (Internal production control) and is from the Siebert Engineering office for plastic technique, Hamburg, also supervised. The manufacturer also especially commits itself to withholding the promised specifications of its products through self control. In this framework, every delivered production (charge), the E-modulus and material shrinkage is checked prior to shipment.
The agreement signed proves the agreement of the supplied goods with the suppliers' specifications.

5.2 Personnel

The persons engaged in the process must be trained according to the training program (Annex 6.4.2) of the I.S.T GmbH. This training program is to be repeated every twelve months. The successful completion of the training is then confirmed through a certificate handed to each pupil (Annex 6.4.3).

5.3 Performing the rehabilitation

The inversion and the used materials are to be detailed on a repair protocol (Annex 6.4.1). A copy of this repair protocol is to be handed to the client. The original must be kept safe for an agreed length of time. From the fibre glass mat is a retainment sample of > 10 x 10 cm², from the EasyPur resin is also a retainment sample required of each component, 100 ml (A+B) and 20 ml of component C. Apart from the test samples, every six months, a length of test pipe a liner is to be constructed and on this the E-modulus out of the bending strength (one our and 24 hour values) the creep curve, heat loss and area weight as well as thickness and wall construction of the liner is documented.