General building authority approval/ general type approval

Date: 04.07.2024

Reference: III 54-1.42.3-13/23

Number:
Z-42.3-365

Period of validity
From: **4th July 2024**
Until: **4th July 2029**

Applicant:
IMPREG® GmbH
Eisenbahnstraße 32
72119 Ammerbuch, Germany

Subject of this notice
Construction products and their use for the realisation of CIPP liners with the designation "IMPREG liner" for the rehabilitation of damaged, underground wastewater pipes with circular profiles in nominal widths DN 150 to DN 2000 and with egg-shaped profile cross-sections in the dimensions 250 mm/375 mm up to 1000 mm/1500 mm

The above-mentioned subject of regulation is hereby generally approved/authorised by the building authorities.
This notice comprises 23 pages and 27 annexes.

Translation of the original German version; the translation has not been approved by the Deutsches Institut für Bautechnik

I GENERAL PROVISIONS

1 This notice proves the usability or applicability of the subject matter of the regulation in terms of the state building regulations.

2 This notice does not replace the authorisations, approvals and certificates required by law for the implementation of building projects.

3 This notice is issued without prejudice to the rights of third parties, in particular private property rights.

4 Copies of this notice shall be made available to the user or user of the subject matter of the regulation, notwithstanding any further provisions in the “Special Provisions”. In addition, the user or user of the subject matter of the regulation must be informed that this notice must be available at the place of use or application. Copies must also be made available to the authorities involved on request.

5 This notice must only be reproduced in full. Publication of extracts requires the approval of the Deutsches Institut für Bautechnik (German Institute for Structual Engineering). Texts and drawings of advertising material must not contradict this notice; translations must contain the note "Translation of the original German version not approved by the Deutsches Institut für Bautechnik".

6 This notice is revocable. The provisions may be supplemented and amended at a later date, in particular if new technical findings make this necessary.

7 This notice is based on the information and documents provided by the applicant. Any change to this basis is not covered by this notice and must be disclosed to the Deutsches Institut für Bautechnik without delay.

II SPECIAL PROVISIONS

1 Subject matter of the regulation and scope of use and application

This notice shall apply to the manufacture and use of CIPP liners with the designations "IMPREG liner GL16" (Annex 1) consisting of polyester (UP) or vinyl ester (VE) resin systems for the renovation or rehabilitation of damaged, underground wastewater pipes with circular cross-sections in nominal widths of DN 150 to DN 1500 and with egg-shaped section cross-sections with widths and heights of 250 mm/375 mm up to 1000 mm/1500 mm.

This notice applies to the rehabilitation of wastewater pipes that are intended to discharge wastewater in accordance with DIN 1986-3[1].

The CIPP liners may be used for the rehabilitation of damaged, underground wastewater pipes made of concrete, reinforced concrete, vitrified clay, asbestos-free fiber cement, GRP, PVC-U, PE-HD and cast iron, as well as for wastewater pipes with egg-shaped section cross-sections made of vitrified clay, concrete or masonry clinker, provided that the cross-section of the wastewater pipe to be rehabilitated meets the process-related requirements and the static requirements.

Damaged wastewater pipes are repaired by inserting and subsequently curing a resin-impregnated glass fiber pipe. The resin-impregnated glass fiber pipe is cured either by means of steam application or UV irradiation.

A CIPP liner with an outer film must always be used or a preliner must be inserted.

The watertight restoration of the side inlets from the respective rehabilitated wastewater pipe is only permitted using methods for which the general building authority approvals with the associated general type approvals are valid for this purpose.

2 Provisions for the construction products

2.1 Properties and composition

2.1.1 General information

Where applicable, the CIPP liners specified in section 1 fulfil the requirements of DIN EN ISO 11296-4[2], they have the specific properties and compositions listed below.

2.1.2 Materials of the CIPP liner components in the "M" condition

2.1.2.1 Materials for the glass fiber pipes

The materials for the PA/PE inner film of the glass fiber pipes and the outer UV-protected PE/PA/PE protective film must comply with the specifications deposited with the Deutsches Institut für Bautechnik.

Glass fiber pipes with a multi-layer wall structure are used for the rehabilitation (Annex 1).

Only resins and hardener components that also comply with the formulation specifications deposited with the Deutsches Institut für Bautechnik may be used to impregnate the glass fiber pipes.

Only unsaturated polyester resins (UP resins based on Isophatal acid (Iso-Npg) and Neopentyl glycol (Ortho-Npg) in accordance with DIN 18820-1[3], Table 1, Group 3) of type 1140 in

[1] DIN 1986-3 Drainage systems for buildings and properties – Part 3: Rules for operation and maintenance; Issued: 2004-11

[2] DIN EN ISO 11296-4 Plastic piping systems for the renovation of underground non-pressure drainage and sewerage networks (gravity pipeline) – Part 4: Lining with cured-in-place pipes (ISO 11296-4:2018); German version EN ISO 11296-4:2018; Issued: 2018-09

[3] DIN 18820-1 Laminates of textile glass-reinforced unsaturated polyester and phenacrylic resins for load-bearing structural members (GF-UP, GF-PHA); structure, manufacture and characteristics; Issued: 1991-03

accordance with Table 3 or vinyl ester resins (VE resins in accordance with DIN 18820-1[3]Table 1, Group 5) of type 1310 according to Table 4 of DIN 16946-2[4] can be used.

The polyester and vinyl ester resins must comply with the formulations and IR spectra deposited with the Deutsches Institut für Bautechnik. The IR spectra must also be deposited with the third-party monitoring body by the holder of this notice.

Only E-CR glass fibers in accordance with DIN EN ISO 2078[5] that meet the requirements of DIN EN 14020-1[6], DIN EN 14020-2[7] and DIN EN 14020-3[8] may be used. Glass fibers with the manufacturer's designation "Advantex" must meet the requirements of these standards.

The polyester nonwovens variant 1 or the resin-rich glass fiber mat (pure resin layer) variant 2 (Annex 1, point 4) used to reinforce the resin-rich inner layer facing the wastewater must comply with the formulation specifications deposited with the Deutsches Institut für Bautechnik.

Only films whose defects do not give any indication of functional failure must be used. The films must be able to withstand an elongation of approx. 15% without cracking.

2.1.2.2 Material of the swelling belt

Only extruded profiles consisting of a chloropene (CR/SBR) rubber and water-absorbing resin must be used for the swelling belt (auxiliary material) in the area of the manhole connection of the CIPP liner. The swelling belts must have a volume increase of at least 100% after 72 hours when stored in water.

2.1.3 Environmental compatibility

In compliance with the special provisions of this notice, the construction products fulfil the "Principles for assessing the impact of construction products on soil and groundwater" (version: 2011; publications of the Deutsches Institut für Bautechnik), and thus the standard set by the "Anforderungen an bauliche Anlagen bezüglich der Auswirkungen auf Boden und Gewässer" (Requirements for buildings with regard to the impact on soil and water) (ABuG; Annex 10 of the Model Administrative Provisions – Technical Building Rules 2023/1).

The reservation of permission of the responsible water authority, in particular in water protection areas, shall remain unaffected.

2.2 Manufacturing, packaging, transport, storage and labelling

2.2.1 Factory production of the GRP CIPP liner

CIPP liners must be manufactured in the applicant's factory from the glass fiber fabric sheets, PES nonwovens and films with properties in accordance with section 2.1.2.1 purchased from preliminary suppliers.

For this purpose, the PE/PA/PE outer film must be fed to the production machine in accordance with the respective unwound nominal width or the unwound circumference of egg-shaped profiles. Seamlessly overlapping glass fiber fabric sheets must be arranged in several layers on the outer foil in such a way that the respective design wall thickness required on the basis of the static calculation is achieved in accordance with the information in the tables in Annexes 2 to 3. The PES fleece (variant 1) or the glass fiber mat (variant 2) must be applied to the glass fiber fabric sheets (Annex 1). The PA/PE inner film must be fed into the production machine as a seamless pipe with a nominal diameter. The glass fiber fabric sheets are folded overlapping to form a complete pipe (liner) using a dimension-related guide device in a continuous machine production process. The outer PE/PA/PE film therefore completely

4	DIN 16946-2	Reactive resin moulding materials; Cast resin moulding materials; types; Issued: 1989-03
5	DIN EN ISO 2078	Textile glass – Yarns – Designation (ISO 2078:1993); German version EN ISO 2078:1994; Issued: 1994-12
6	DIN EN 14020-1	Reinforcements – Specification for textile glass rovings– Part 1: Designation; German version EN 14020-1:2002; Issued: 2003-03
7	DIN EN 14020-2	Reinforcements – Specification for textile glass rovings – Part 2: Methods of test and general requirements; German version EN 14020-2:2002; Issued: 2003-03
8	DIN EN 14020-3	Reinforcements – Specification for textile glass rovings – Part 3: Special requirements; German version EN 14020-3:2002; Issued: 2003-03

encases the pipe. The open sides of the PE/PA/PE film must be continuously welded together to make them watertight and airtight.

For the subsequent resin impregnation of the glass fiber fabric pipes, the proportions of the components of the reaction resin must be continuously added in accordance with the formulation specifications deposited with the Deutsches Institut für Bautechnik using mixing equipment and several compulsory mixers known as "turbo mixers". Compliance with the formulation must be ensured by checking the cylinder stroke volumes to be set before mixing begins. Compliance with the formulation must be permanently monitored and checked. The continuous weight loss of the containers connected to the mixing and dosing unit must be monitored and recorded.

For resin impregnation, the CIPP liner is guided over a conveyor belt. The resin filling of the CIPP liner must be carried out continuously. To support the resin impregnation, a vacuum of approx. 0.2 bar must be generated in the CIPP liner by means of a vacuum system. The CIPP liner must be fed through a roller mill in order to achieve uniform resin impregnation.

The CIPP liners must then be placed in layers in suitable transport containers.

CIPP liners intended for UV curing must be placed in in layers in lightproof transport containers.

The production parameters to be observed for CIPP liner production, resin mixing and resin impregnation are deposited with the Deutsches Institut für Bautechnik and must be made known to the external monitoring body when carrying out the external inspection in accordance with section 2.3.3.

The relevant accident prevention regulations and health and safety regulations must be observed during the manufacture of glass fiber pipes and during resin impregnation. In particular, the "limit values in the air" in the technical regulation for hazardous substances TRGS 900[9] must be observed with regard to styrene. It must be ensured that the styrene limit values in particular are not exceeded by means of suitable measures (e.g. extraction equipment).

When handling the soaked pipes, the applicable accident prevention regulations and the regulations according to the law on hazardous substances (German Ordinance on Hazardous Substances) must be observed.

2.2.2 Packaging, transportation, storage

The resin delivered to the applicant's manufacturing plant for the factory pipe production must be stored in suitable storage containers in temperature-controlled storage rooms with a monitored temperature range of +5 °C to approx. +25 °C.

Resin-impregnated CIPP liners for steam curing can be stored for at least three weeks in temperature-controlled storage rooms with a temperature range of +5 °C to +8 °C.

In lightproof transport containers, impregnated CIPP liners up to 10 mm composite wall thickness can be stored for six months for UV curing and for CIPP liners greater than 10 mm composite wall thickness (with peroxides) for 30 days after the production date at a temperature between +5 °C and +25 °C.

In transport containers, impregnated CIPP liners for steam curing of nominal diameters smaller than DN 600 can be stored for a maximum of three weeks from the date of delivery and nominal diameters larger than DN 600 for a maximum of two weeks from the date of delivery at a temperature of +10 °C to +18 °C. The transport containers must be protected from direct sunlight or heat sources.

The relevant accident prevention regulations must be observed during storage and transportation.

[9] TRGS 900 Technical Rules for Hazardous Substances – Limit values for air at the workplace "Air limit values"; Issued: 12.06.2023

2.2.3 Labelling

The transport containers of the CIPP liners must be labelled with the conformity mark (Ü mark) in accordance with the conformity mark regulations of the federal states, including the notification number Z-42.3-365. Labelling must only be carried out if the requirements in section 2.3 are met.

The manufacturer must indicate the hazard symbols and H and P phrases on the containers, on the packaging, on the package insert or in the delivery note in accordance with the Hazardous Substances Ordinance and EU Regulation No. 1907/2006 (REACH) as well as the respective current version of the CLP Regulation (EC) 1272/2008[10]. The packaging must be labelled in accordance with the regulations of the ADR[11] in the respective valid versions.

In addition, please indicate:

- Nominal diameter
- Composite wall thickness
- Pipe length
- Date of resin impregnation
- UP or VE resin
- UV and/or steam curing
- Production site (place of resin impregnation)
- Identification number
- Storage temperature range
- Reference to light sensitivity (for CIPP liners for UV curing)

2.3 Certificate of compliance

2.3.1 General information

Certificate of compliance for the construction products with the provisions of the general building authority approval covered by this notice must be provided for each manufacturing plant with a declaration of conformity on the basis of an in-house production control and a certificate of conformity from a certification body recognised for this purpose as well as regular external monitoring by a recognised monitoring body including initial testing of the construction products in accordance with the following provisions.

The manufacturer of the construction products must involve a recognised certification body and a recognised monitoring body for the issuing of the certificate of conformity and external monitoring, including the product tests to be carried out.

The manufacturer must submit the declaration of conformity by labelling the construction products with the mark of conformity (Ü mark) with reference to the intended use.

The certification body shall provide the Deutsches Institut für Bautechnik with a copy of the certificate of conformity issued by it.

The Deutsches Institut für Bautechnik must also be provided with a copy of the initial test report.

2.3.2 In-house production control

An in-house production control must be set up and implemented in each manufacturing plant. In-house production control is understood to mean the continuous monitoring of production to be carried out by the manufacturer to ensure that the construction products manufactured by them comply with the provisions of the general building authority approval covered by this notice.

[10]	1272/2008	Regulation (EC) No. 1272/2008 on the classification, labelling and packaging of substances and mixtures
[11]	ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road *(Accord européen relatif au transport international des marchandises Dangereuses par Route)*

The in-house production control should include at least the measures listed below:

- Description and review of the source material:
  1) To the CIPP liner materials:

     For each delivery of the components protective films, glass fibers, polyester nonwovens, resins and auxiliary materials, the applicant shall ensure that the formulation specifications provided (section 2.1.2.1) is complied with. For this purpose, the applicant must have the respective upstream supplier submit the corresponding 2.2 works certificates in accordance with DIN EN 10204[12].

     The following properties must be randomly checked as part of the incoming goods inspection:

     a) Properties of UP and VE resins:
        - Viscosity
        - Reactivity

     b) Properties of glass fiber fabric sheets:
        - Single raw wall thicknesses
        - Grammage

     c) Properties of protective films made of PE/PA and PE/PA/PE:
        - Elongation
        - Visual assessment for defects

  2) To the swelling belts (auxiliary materials):

     For each delivery, the contractor must obtain from the preliminary supplier a works certificate 2.1 in accordance with DIN EN 10204[12] to confirm the properties specified in section 2.1.2.2.

     Compliance with the geometric requirements (profile shape and dimensions) of the swelling belts in accordance with Annex 25 must be checked visually and by random remeasurement as part of the incoming goods inspection.

- Checks and tests to be carried out during manufacture:

  When manufacturing the glass fiber pipe (assembling the CIPP liner) in accordance with the specifications in section 2.2.1, at least the following parameters must be checked and recorded for each order:
  - Flat width of the CIPP liner
  - Inner film width
  - CIPP liner length
  - Number of fabric layers
  - Checking the welding parameters (including welding temperature and uniformity of the welded joints of the protective films)

  During impregnation or resin impregnation in accordance with the specifications in section 2.2.1, at least the following parameters must be checked and recorded on an order-related basis:
  - Uniformity and cleanliness of the supporting material
  - Uniformity of the resin impregnation
  - Resin quantity
  - Batch number of the resin, the auxiliary materials
  - Total CIPP liner wall thickness (roller spacing of the calibration rollers)

[12] DIN EN 10204 Metallic products – Types of inspection certificates; German version EN 10204:2004; Issued: 2005-01

- CIPP liner length

- Checking the containers:

  The labelling requirements according to section 2.2.3 must be checked.

- Tests on hardened test samples for production control:

  As part of the in-house production control, test samples must be produced for random checks of the properties specified in sections 3.1.2.1.1 and 3.1.2.1.3. Care must be taken to ensure that these test samples are not exposed to uncontrolled UV radiation. The respective test sample must be set up in the applicant's laboratory under the same criteria as described in sections 3.2.3.9 to 3.2.3.11 by applying an internal pressure in accordance with the specifications in the table in Annex 5 to the respective nominal diameter and cured either by means of the curing by UV lamps mentioned in section 3.2.3.10 or the vapour described in section 3.2.3.11.

  At least the following tests must be carried out on this sample or samples taken from it:

  - Tightness of the laminate:

    The tightness of the cured GRP CIPP liner must be tested without film coating in accordance with the criteria of DIN EN 1610[13] (LD method).

  - Glass fiber content/resin content

    The glass and resin content must be checked on cured test pieces.

  - Wall thicknesses and wall structure:

    The composite wall thickness must be checked by measuring the samples taken. The wall structure must be checked in accordance with the specifications in section 3.1.2.1.1.

  - Strength properties:

    Ring stiffness and elastic modulus must be determined on the hardened test sample in accordance with DIN EN 1228[14] or DIN 53769-3[15].

    When changing the resin supplier, at least one complete circular ring (pipe section) must also be removed from the cured CIPP liner. The ring stiffness and the short-term elastic modulus according to DIN 53769-3[15] must be determined.

  - Visual inspection:

    The surfaces of the cured test sample must be checked for damage and defects.

The results of the in-house production control must be recorded and evaluated. The records must contain at least the following information:

- Designation of the construction products or the source materials and the components,
- Type of inspection or test,
- Date of manufacture and testing of the construction products or source materials or components,
- Result of the checks and tests and, where applicable, comparison with the requirements,
- Signature of the person responsible for the in-house production control.

The records must be kept for at least five years and submitted to the monitoring body responsible for external monitoring. They must be submitted to the Deutsches Institut für Bautechnik and the competent highest building supervisory authority on request.

If the test result is unsatisfactory, the manufacturer must immediately take the necessary

13	DIN EN 1610	Installation and testing of wastewater pipes and sewers; German version EN 1610:2015; Issued: 2015-12
14	DIN EN 1228	Plastics piping systems – Glass reinforced thermosetting plastics (GRP) pipes – Determination of initial ring stiffness; German version EN 1228:1996; Issued: 1996-08
15	DIN 53769-3	Testing of pipelines made of glass reinforced plastics; Short-term and ring stiffness test on pipes; Issued: 1988-11

measures to rectify the defect. Construction products that do not fulfil the requirements must be handled in such a way that confusion with matching products is ruled out. Once the defect has been rectified, the relevant test must be repeated immediately – insofar as technically possible and necessary to prove that the defect has been rectified.

2.3.3 External monitoring

In each manufacturing plant, the plant and the in-house production control system must be inspected regularly by an external monitoring organisation, but at least once every six months.

An initial inspection of the construction products must be carried out as part of the external monitoring. The in-house production control must be carried out as part of external monitoring by means of random checks. The requirements of sections 2.1.2 and 2.2.3 must be checked.

The requirements for manufacture in accordance with section 2.2.1 must be randomly checked. This also includes checking the curing behaviour, storage stability and grammage after curing, as well as the IR spectroscopy.

Sampling and testing are the responsibility of the recognised monitoring body. During external monitoring, factory certificates 2.1 and factory certificates 2.2 in accordance with DIN EN 10204[12] must also be checked.

The results of certification and external monitoring must be kept for at least five years. They must be submitted by the certification body or the inspection body to the Deutsches Institut für Bautechnik and the competent highest building supervisory authority on request.

3 Provisions for the application of the subject matter of the regulation

3.1 Planning and dimensioning

3.1.1 Planning

The details of the necessary sewer and pipe data must be checked by the person carrying out the work, in particular the routing, depth, position of the lateral connections, manhole depths, groundwater, pipe connections, hydraulic conditions, inspection openings, cleaning intervals. Existing video recordings must be analysed in relation to the application. The accuracy of the information must be checked on site. The condition of the existing wastewater pipe in the property drainage system must be assessed with regard to the applicability of the rehabilitation procedure.

The hydraulic efficiency of the wastewater pipes must not be impaired by the installation of a CIPP liner. Corresponding proof must be provided if necessary.

3.1.2 Dimensioning

3.1.2.1 CIPP liner in the "I" state

3.1.2.1.1 Wall thicknesses and wall structure

Depending on the system, resin-impregnated CIPP liners are used for a rehabilitation measure which, after inversion and curing, have a design wall thickness of at least 3 mm in accordance with the tables in Annexes 2 and 3.

Wastewater pipes whose load-bearing capacity alone (without support of the surrounding soil) is given, i.e. no cracks (except hairline cracks with crack widths of less than 0.15 mm or less than 0.3 mm for reinforced concrete pipes) are present, must only be rehabilitated with CIPP liners in accordance with Annexes 2 and 3 if the nominal stiffness $SN \geq 500\ N/m^2$ is complied with. If there are one or more continuous longitudinal cracks in the host pipe, soil investigations, e.g. by dynamic probing, are required and a corresponding mathematical verification must be carried out. In the case of infiltrations, the CIPP liner must also be dimensioned with regard to deformation and buckling behaviour.

If the host pipe floor system alone is no longer load-bearing, such wastewater pipes must only be rehabilitated with CIPP liners with the design wall thicknesses listed in Annexes 2 and 3 if the static loads to be absorbed by the CIPP liner are verified by a stability verification in

accordance with worksheet DWA-A 143-2[16].

The following relations apply to the nominal stiffness SN and short-term ring stiffness SR specified in the tables in Annexes 2 and 3:

The following applies for SN:

$$SN = \frac{E \cdot s^3}{12 \cdot d_m^3}$$

The following applies for SR:

$$SR = \frac{E \cdot s^3}{12 \cdot r_m^3}$$

(SN = nominal stiffness based on DIN 16869-2[17])

For the groundwater load case, the CIPP liner must also be tested for buckling in accordance with worksheet DWA-A 143-2[16] (see also section 3.1.2.1.4).

Regardless of the result of the stability verification, the SDR maximum value of the design wall thickness of 135 must not be exceeded.

After installation and curing, the CIPP liners must have a multi-layered wall structure; consisting of the UV-protected PE/PA/PE film, the resin-impregnated polyester fleece coated with PE/PA or PE/PA/PE plastic film, the glass fiber layer consisting of multi-layer resin-impregnated ECR glass fiber mats and the inner resin-impregnated ECR glass fiber mats (pure resin layer) as well as the inner PA/PE film (Annex 1). The inner PA/PE film is removed from the CIPP liner after curing.

3.1.2.1.2 Dimensions of CIPP liners for egg-shaped sections

The pipe lining method must also be used to rehabilitate defective wastewater pipes with egg-shaped section cross-sections that correspond to the width and height dimensions specified in Annex 4 with the corresponding design wall thicknesses. Other width and height ratios must also be rehabilitated on the basis of an on-site determination of the inner circumference of the wastewater pipe to be rehabilitated.

3.1.2.1.3 Physical characteristics of the cured CIPP liner

The cured CIPP liners (laminate without PE/PA/PE coating and without PA/PE inner film) must have the following minimum characteristic values (testing of the test pieces with the composite wall thickness = design wall thickness plus wear layer and pure resin layer = laminate):

1) "IMPREG liner GL16" for steam and UV curing with UP resin, DN 150 to DN 1500 (composite wall thickness):
   - Density based on DIN EN ISO 1183-2[18]: 1.64 g/cm³ ± 10%
   - Glass content based on DIN EN ISO 1172[19]: 55% ± 10%
   - Glass surface weight per mm of composite wall thickness: 890 g/m² ± 15%
   - Short-term circumferential elastic modulus based on DIN EN 1228[14]: ≥ 12,415 MPa
   - Bending elastic modulus based on DIN EN ISO 11296-4[2] or DIN EN ISO 178[20]: ≥ 13,800 MPa
   - Bending stress σ_{fB} based on DIN EN ISO 11296-4[2] or DIN EN ISO 178[20]: ≥ 175 MPa

16	DWA-A 143-2	German Association for Water, Wastewater and Waste (DWA) – Code of Practice 143: Rehabilitation of drainage systems outside buildings Part 2: Static calculation for the rehabilitation of wastewater pipes and sewers with lining and assembly methods; Issued: 2015-07
17	DIN 16869-2	Centrifugally cast filled glass fiber reinforced unsaturated polyester resin (UP-GF) pipes – Part 2 General quality requirements, testing; Issued: 1995-12
18	DIN EN ISO 1183-2	Plastics – Methods for determining the density of non-cellular plastics – Part 2: Density gradient column method (ISO 1183-2:2019); German version EN ISO 1183-2:2019; Issued: 2019-06
19	DIN EN ISO 1172	Textile-glass-reinforced plastics — Prepregs, moulding compounds and laminates — Determination of the textile-glass and mineral-filler content; calcination methods (ISO 1172:1996); German version EN ISO 1172:1998; Issued: 1998-12
20	DIN EN ISO 178	Plastics Determination of flexural properties (ISO 178:2019); German version EN ISO 178:2019; Issued: 2019-08

2.) "IMPREG liner GL16" for steam and UV curing with VE resin, DN 150 to DN 1500 (composite wall thickness):

- Density based on DIN EN ISO 1183-2[18]: 1.64 g/cm³ ± 10%
- Glass content based on DIN EN ISO 1172[19]: 50% ± 10%
- Glass surface weight per mm of composite wall thickness: 890 g/m² ± 15%
- Short-term circumferential elastic modulus based on DIN EN 1228[14]: ≥ 13,976 MPa
- Bending elastic modulus based on DIN EN ISO 11296-4[2] or DIN EN ISO 178[20]: ≥ 13,200 MPa
- Bending stress σ_{fB} based on DIN EN ISO 11296-4[2] or DIN EN ISO 178[20]: ≥ 220 MPa

The residual styrene content in accordance with DIN 53394-2[21] must not exceed the maximum value of 2% (based on the laminate).

3.1.2.1.4 Static calculation of the cured CIPP liner

The stability of the planned CIPP liners for each rehabilitation measure must be verified by means of a static calculation in accordance with worksheet DWA-A 143-2[16] of the "Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e. V. (DWA)" (German Association for Water, Wastewater and Waste) prior to execution.

For the stability verification of the CIPP liners, the following values, including the partial safety factor γ_M for the CIPP liner material and the reduction factor A for determining the long-term values in accordance with DIN EN 761[22] must be taken into account:

1.) "IMPREG liner GL16" for steam and UV curing with UP resin, DN 150 to DN 1500 (design wall thickness):

- Short-term circumferential elastic modulus based on DIN EN 1228[14]: ≥ 15,600 MPa
- Long-term circumferential elastic modulus: ≥ 13,000 MPa
- Bending stress σ_{fB} based on DIN EN ISO 11296-4[2] or DIN EN ISO 178[20]: ≥ 245 MPa
- Long-term bending stress σ_{fB}: ≥ 204 MPa
- Partial safety factor γ_M 1.35
- Reduction factor A after 10,000 hrs: 1.20

2.) "IMPREG liner GL16" for steam and UV curing with VE resin, DN 150 to DN 1500 (design wall thickness):

- Short-term circumferential elastic modulus based on DIN EN 1228[14]: ≥ 14,645 MPa
- Long-term circumferential elastic modulus: ≥ 11,623 MPa
- Bending stress σ_{fB} based on DIN EN ISO 11296-4[2] or DIN EN ISO 178[20]: ≥ 388 MPa
- Long-term bending stress σ_{fB}: ≥ 307 MPa
- Partial safety factor γ_M 1.35
- Reduction factor A after 10,000 hrs: 1.26

[21]	DIN 53394-2	Testing of plastics; determination of the percentage of styrene in reactive resin moulding materials based on unsaturated polyester resins; gas chromatography method; Issued: 1993-12
[22]	DIN EN 761	Plastic piping systems – glass-reinforced thermosetting plastics (GRP) pipes – determination of the creep factor under dry conditions; German version EN 761:1994; Issued: 1994-08

3.2 Execution

3.2.1 General information

Damaged wastewater pipes are repaired by inserting and subsequently curing a resin-impregnated glass fiber pipe. The resin-impregnated glass fiber pipe is cured either by means of steam application or UV irradiation.

For this purpose, a PE gliding film must be inserted into the damaged pipe. For sections ≤ DN 500 and an undamaged invert and minimal misaligned joints, a gliding film is not required. It must be ensured that all obstacles have been removed in advance. The resin-impregnated glass fiber pipe, which is enclosed airtight on the outside with a UV-protected PE/PA/PE protective film and a PA/PE protective film applied to the inside, is pulled into the damaged pipe on this gliding film and positioned by means of compressed air. Glass fiber pipes in nominal sizes DN 150 to DN 1500 or 250 mm/375 mm to 1000 mm/1500 mm, which are hardened using steam or UV radiation, are pulled into the damaged pipe with a UV-protected PE/PA/PE protective film.

The "IMPREGLiners" can be used in the following structural conditions:

a) From start to finish
b) From start to finish via an intermediate manhole
c) Starting from the starting point in a channel position with a defined length, without the need for a further manhole opening
d) Side inlets, starting from the starting point to the connection point in the main channel

The starting point or target point can be a manhole, an inspection or cleaning opening or an open pipe section. The prerequisite is that the size is sufficient to erect the inversion scaffolding.

Several manholes can also be crossed between the respective start and finish points, including the crossing of manholes with channel deflections of up to 30 degrees.

If creasing occurs, it must not be greater than specified in DIN EN ISO 11296-4[2] is specified.

The watertight reconnection of lateral connections must be carried out either in open construction or using repair or rehabilitation methods for which general building authority approvals with the associated general type approvals for this purpose are valid.

The applicant must provide the person carrying out the work with a manual describing the individual steps relating to the type of execution (see also section 4.3).

The applicant must also ensure that those carrying out the work are adequately familiarised with the procedure. The sufficient expertise of the company carrying out the work can be documented, e.g. by a corresponding quality mark from Güteschutz Kanalbau e. V.[23].

3.2.2 Devices and equipment

The minimum equipment, components and facilities required to carry out the rehabilitation procedure are:

- Sewer cleaning equipment
- Sewer inspection equipment (DWA-M 149-2[24])
- Rehabilitation equipment/vehicle equipment for steam curing:
  - GRP CIPP liner in the appropriate nominal diameters (Annex 1)
  - Gliding film
  - Steam generator
  - Control devices for steam temperatures
  - Control devices for pressure monitoring

[23] Güteschutz Kanalbau e. V.; Linzer Str. 21, Bad Honnef, Germany, phone: +49 (0) 2224 9384 0, fax: +49 (0) 2224 9384 84

[24] DWA-M 149-2 German Association for Water, Wastewater and Waste (DWA) – Code of Practice 149: Condition survey and assessment of drainage systems outside buildings – Part 2: Coding system for optical inspection; Issued: 2013-12

- Nominal diameter-related sealing plugs (also known as packers) for circular cross-sections in the nominal diameters DN 150 to DN 1500 with compressed air connections and for egg-shaped cross-sections in the dimensions 250 mm/375 mm up to 1000 mm/1500 mm with compressed air connections
- Compressor with compressed-air pipes (including spare compressor)
- Pressure pipes
- Power generator/power supply
- Steam outlet device
- Workshop and equipment room
- Social and sanitary rooms, if applicable

– Rehabilitation equipment/vehicle equipment for UV curing:

- GRP CIPP liner in the appropriate nominal diameters (Annex 1)
- Gliding film
- UV light chains/UV light cores (nominal width-related)
- Electrical connection cables for image/data transmission
- Temperature probes
- Control devices for pressure monitoring
- Power measuring device for UV radiation
- UV replacement lamps
- Swivel (to prevent twisting during CIPP liner insertion)
- Nominal diameter-related sealing plugs (also known as packers) for circular cross-sections in the nominal diameters DN 150 to DN 1500 with compressed air connections and for egg-shaped cross-sections in the dimensions 250 mm/375 mm up to 1000 mm/1500 mm with compressed air connections
- Compressor (including spare compressor)
- Compressed-air pipes
- Power generator/power supply
- Radial compressor
- Winch with monitoring and control device for the feed forces
- Workshop and equipment room
- Lifting device
- Recording devices for the curing temperatures
- Edge protection at the manhole and between the manhole and wastewater pipe
- Social and sanitary rooms, if applicable

If electrical devices, e.g. video cameras (or so-called remote sewer eyes) are installed in the pipe to be rehabilitated, they must be designed in accordance with VDE regulations.

3.2.3 Implementation of the rehabilitation measure

3.2.3.1 Preparatory measures

Before the rehabilitation measure is carried out, it must be ensured that the pipe in question is not in operation; if necessary, appropriate inflatable pipe plugs must be installed and the wastewater diverted (Annex 14). The wastewater pipe to be rehabilitated must be cleaned to such an extent (Annex 15) that the damages can be clearly recognised on the monitor (Annex 16). If necessary, obstacles to the insertion of the CIPP liner must be removed (e.g. root ingrowths, protruding lateral connection pipes, tar lenses, etc.). When removing such obstacles, make sure that only suitable tools are used so that the existing wastewater pipe is not additionally damaged.

The accuracy of the information given in section 3.1.1 must be checked on site. For this purpose, the pipe section to be rehabilitated must be cleaned with standard high-pressure flushing devices to such an extent that the damage on the monitor is visible during the visual inspection in accordance with Code of Practice DWA-M 149-2[24] can be clearly recognised.

The accident prevention regulations applicable to the application of the rehabilitation procedure must be observed.

Persons must only enter the manholes of the wastewater pipe to be rehabilitated if it has first been ensured by testing that no flammable gases are present in the pipe section. The same applies to devices used in the rehabilitation procedure that are to be installed in the pipe section to be rehabilitated.

The relevant sections of the following regulations must be observed:

- GUV-R 126 (previously GUV 17.6) **[25]**
- DWA-M 149-2**[24]**
- DWA-A 199-1 and DWA-A 199-2[26]

When using steam generators and devices for steam curing, the law on technical work equipment (Equipment Safety Act) and the ordinance on steam boiler systems (Steam Boiler Ordinance) must be observed in particular.

The applicant shall provide the executing party with a manual describing the individual steps relating to the type of execution.

The steps required to carry out the procedure must be recorded using record forms for each rehabilitation.

3.2.3.2 Incoming goods inspection of the process components on the construction site

The delivered CIPP liners must be checked on-site to ensure that the markings specified in section 2.2.3 are present.

3.2.3.3 Checking the UV lamps

Brand-new UV lamps must be tested for the first time after an operating time of approx. 400 hours using a calibrated measuring device by means of a comparative measurement (Annex 25). Each lamp must then be checked every 150 operating hours.

3.2.3.4 Arrangement of support tubes and support pipes

Before the protective pipe (PVC or PE preliner) is fed in, support tubes or support pipes may need to be positioned to extend the wastewater pipe to be rehabilitated or in the area of intermediate manholes so that samples (sample pipes) can be taken at these points at the end of the rehabilitation measure.

3.2.3.5 Inserting the gliding film

Before CIPP liners delivered to the construction site can be removed from the transport container and pulled into the damaged wastewater pipe, a gliding film, e.g. made of PE, must be inserted (Annex 17). This film also serves as a protective film during the retraction process. For sections ≤ DN 500 and an undamaged invert and minimal misaligned joints, a gliding film is not required. It must be ensured that all obstacles have been removed in advance.

3.2.3.6 Placing collars (safety caps)

The CIPP liner must be fitted with a collar (safety cap) made of fabric or sheet steel in the start and target manholes and in the intermediate manholes. The outer diameter of the collar must

25	GUV-R 126	Safety rules: Work in enclosed areas of wastewater treatment plants (previously GUV 17.6); Issued:2008-09
26	DWA-A 199-1	German Association for Water, Wastewater and Waste (DWA) – Code of Practice 199: Service and operating instructions for the personnel of wastewater treatment plants, – Part 1: Instructions for the personnel of wastewater treatment plants; Issued: 2011-11
	DWA-A 199-2	German Association for Water, Wastewater and Waste (DWA) – Code of Practice 199: Service and operating instructions for the personnel of wastewater treatment plants, – Part 2: Operating instructions for the personnel of sewer networks and rainwater treatment plants; Issued: 2020-04

correspond to the inner diameter of the pipe to be rehabilitated. This is intended to simulate the supporting effect of the existing line. Only the applicant's safety caps should be used.

For egg-shaped sections with width and height dimensions of 200 mm/300 mm to 500 mm/700 mm in the non-accessible area, such a sample pipe can be placed in intermediate manholes if sampling from the rehabilitated pipe is not possible. When placing the expansion limiters, make sure that they protrude from the respective manhole wall to a length of approx. 20 cm to 25 cm between the CIPP liner and the pipe to be rehabilitated.

After the CIPP liner has been inserted and cured, samples must be taken in the areas of the safety caps (see section 3.2.5).

3.2.3.7 Pulling in the CIPP liner

Care must be taken to ensure that the transport container of the CIPP liner is not exposed to direct sunlight. In the case of CIPP liners for UV curing, the CIPP liner must be removed from the transport container in such a way that the UV-protected PE/PA/PE protective film of the tube CIPP liner is not damaged.

A so-called "feed head" must be created at the end of the CIPP liner, i.e. the CIPP liner must be folded lengthways so that a feed cable can be attached (e.g. using tensioning straps).

The CIPP liner must be fed into the pipe to be rehabilitated via the electrically operated cable winch, if necessary via deflection rollers at the edge of the starting shaft and a deflection bend or a deflection roller corresponding to the nominal diameter of the pipe to be rehabilitated (Annex 18). Care must be taken to ensure that the CIPP liner is not damaged. For this purpose, the edge of the feed manhole and the area between the manhole and the wastewater pipe should be provided with edge protection.

A biodegradable oil can be applied to the gliding film to reduce the feed forces. When feeding, it must also be ensured that the maximum feed forces specified in the table in Annex 5 are not exceeded.

If possible, the electric cable winch should be retracted without stopping. When feeding, care must be taken to ensure that the CIPP liner does not twist along its longitudinal axis by using so-called swivels. The winch type must be recorded. It must be ensured that the maximum tensile forces in accordance with Annex 5 are not exceeded. This can be done using a force limiter or the maximum power of the winch. The feed speed must not exceed 5 m/min.

3.2.3.8 Positioning swelling belts (auxiliary materials)

After pulling in the CIPP liner and before setting up the CIPP liner, one or two swelling belts must be set at a distance of approx. 20 cm to 25 cm from the start of the pipe to be rehabilitated (Annex 24). These must be positioned by hand. It is also possible to set the swelling belts in the same way for each manhole passed through and at the manhole shaft.

3.2.3.9 Setting up the CIPP liner (Annex 19) and inserting the UV light sources

After the packers have been installed, the 8 mm thick curing rope must be inserted into the CIPP liner. To do this, the packer is connected to the compressor or compactor and supplied with compressed air. The CIPP liner must be pressed down at the end manhole so that the CIPP liner slowly rises. The curing rope must be replaced via the inserted Kevlar thread. Ensure that the curing rope is pulled straight and not across corners.

The UV lamps (according to Annex 9) must now be attached to the curing rope and inserted into the manhole. Using compressed air, the CIPP liner can be easily set up again so that the chain can be inserted without damaging the inner film. The chain must be inserted into the CIPP liner with the utmost care. Care must be taken to ensure that the wheels and other parts of the chain do not damage the inner film. It may be necessary to pause the introduction of the chain at various intervals to allow the pipe to be reinflated.

From a nominal diameter of DN 500, the light chain can be inserted through an airlock. This airlock must be attached to the outside of the end packer with tensioning straps. To do this, the cap must first be removed from the packer. The UV light train must then be inserted into the airlock. Then insert the UV lamps into the pipe under moderately compressed air.

To ensure that the resin cures evenly across the entire cross section, the UV light source must always be set up in a central position. For egg-shaped pipe sections, wheel extensions that are suitable for the size of the egg-shaped pipe must be used. Furthermore, the UV lamps must be clean and provide an appropriate UV spectrum output.

3.2.3.10 Curing the CIPP liner using a UV light source

Using UV light sources, CIPP liners of nominal widths DN 150 with a design wall thickness of 3 mm up to nominal width DN 1500 with a maximum composite wall thickness of 18 mm can be rehabilitated in compliance with the specifications in section 2.1.2.1. The applicant's installation instructions and the following provisions must also be observed.

3.2.3.10.1 Calibration of the GRP CIPP liner

The installation of the CIPP liner using compressed air must be carried out in several steps. The CIPP liner must be set up slowly and in stages of 0.02 bar/min until the working pressure is reached in accordance with Annex 5. Three to five short breaks of approx. 5 minutes should be taken during the set-up phase. If the CIPP liner material temperature is below +10 °C, the waiting time of at least 10 minutes must be observed.

Once the working pressure according to Annex 7 has been reached, it is essential to maintain this working pressure for approx. 10 minutes to ensure that the CIPP liner is not damaged when the UV lamps are fed. Meanwhile, feed the switched-off UV lamps into the start manhole. The CIPP liner must be visually inspected using a camera. The pull-through must be documented by video recording. If the CIPP liner is not optimally positioned in the pipe, the set-up process must be repeated.

3.2.3.10.2 UV light curing of the CIPP liner Annex 21

The UV light source must only be switched on when there are no more people in the launch manhole and the UV light source has been fully inserted into the GRP CIPP liner. It must be switched on in accordance with the instructions in Annex 10.

As soon as the UV light source is switched on, it must be pulled to the target manhole at a speed depending on the nominal width in accordance with the specifications in Annex 11 to 13 (Annex 21).

When UV light sources are switched on, care must be taken to ensure that the specifications given in Annex 11 to 13, in particular those relating to the minimum distances between the individual lamps and the inner surface of the CIPP liner, are observed.

During UV light curing, heat is generated by the reaction of the resin. The resulting temperatures in the surface area of the CIPP liner must not fall below +80 °C and must not exceed +130 °C. Compliance with the temperature range must be continuously checked and recorded using temperature probes while the UV light source is being pulled through. If the surface temperature exceeds +130 °C, the air flow rate must be increased by opening a valve in the packer at the target manhole and simultaneously maintaining the internal pressure, or the temperature must be reduced by utilising the speed spectrum (cm/min) specified in Annex 11 to 13 by means of a fast or slow-moving UV light source.

The pressure curve during light curing, the position of the UV light source, the speed of the UV light source, the functional status of the UV lamps, the air temperature in the surface area of the CIPP liner (at the start, centre and end of the respective UV light source) and the external temperature on the CIPP liner in the start and target manholes must be recorded in each case.

The information in Annex 10 must be observed when switching off.

3.2.3.10.3 Removing the inner film after light curing

After a cooling phase lasting a few minutes, the UV light source must be removed from the cured CIPP liner after depressurisation. Then take out the packers and remove the inner film.

3.2.3.11 Steam curing of the GRP CIPP liner (Annex 20)

3.2.3.11.1 General information

Steam curing must be carried out in accordance with the applicant's installation instructions and the following specifications.

Packers in accordance with section 3.2.3.9 with appropriate connections, e.g. for steam pressure lines, pressure measurement lines and condensate line connections, must be used for steam curing. A pressure line with control valve must be installed in the area of the target manhole for steam curing (Annex 20). In addition, temperature sensors must be installed in the area of the deepest point of the CIPP liner (in the base area) in both the start and target manholes.

After the CIPP liner has been set up using compressed air as described in section 3.2.3.9, the working pressures specified in Annex 5 must be maintained. The installed CIPP liner must be pressurised with steam through the steam pressure line to be connected to the inlet packer, taking into account the curves and temperature maintenance phases shown in Annex 6 to 8. For this purpose, the steam pressure must be monitored using a pressure gauge and regulated via the respective control valve in the target manhole according to the curing curve. When monitoring the temperature, the reduction in the temperature level in the base area due to condensation must be taken into account.

The pressure and temperature curve must be recorded in phases during steam curing using an analogue or digital recording device. The log must correspond to real time. If the recording device fails, a log sheet must be used.

When carrying out steam curing, care must be taken to ensure that any unpleasant odours are largely avoided.

3.2.3.11.2 Condensate drainage and curing

Before the packers are removed after the steam pressure has been released, an inspection opening must be made in the area of the target manhole to check whether any condensate that is produced has been sufficiently removed. If this is not the case and there is condensate in the base area, check whether the CIPP liner in the base area is still soft. If this is the case, the inspection opening must be closed using a hand laminate and the working pressure restored in accordance with Annex 5, the steam temperature increased to +110 °C and maintained for at least 45 minutes. The condensate drainage and the condition of the CIPP liner must then be checked again.

3.2.3.11.3 Opening the CIPP liner and removing the inner film after steam curing

After cooling down and checking the condensate drainage, the CIPP liner must be opened using compressed air-driven cutting tools and the inner film removed.

3.2.3.12 Leak test of the CIPP liner

As an interim test, the tightness of the hardened CIPP liner can be checked before milling the inlets and making the manhole connections in accordance with the criteria of DIN EN 1610[13] (see also section 3.2.3.17).

3.2.3.13 Final work

After opening the CIPP liner in the start and target manholes, the resulting inner pipe must be cut off and removed with an approx. 2 cm to 3 cm wide overhang on the respective manhole wall. In the intermediate manholes, the upper half shell of the resulting pipe must be removed until it enters the manhole floor.

The samples required for the subsequent tests must be taken from the pipe sections also removed in the process (see section 3.2.3.17).

The relevant accident prevention regulations must be observed when carrying out cutting work.

3.2.3.14 Manhole connection

Swelling belts (auxiliary materials, Annex 24) must be used in the manhole connection area.

Manhole connections must be made watertight using swelling auxiliary belts, which must be positioned in the area of the manhole connections before the PE protective hose (preliner) is fed in.

In the respective start and target manholes as well as in the intermediate manholes, the resulting protrusions (see also section 3.2.3.13 – Final work) of the hardened inner pipe to the end wall of the manhole (so-called mirror) and the transitions to the flow channel in the start and target manholes must be made watertight.

In areas where swelling belts (auxiliary belts) cannot be used in the design, the watertight formation of the connection areas between the CIPP liner and the manhole can also be carried out in the following way after the CIPP liner has cured (Annex 23):

a) Connection of the CIPP liner using reaction resin filler, for which a general building authority approval is valid,
b) Connection of the CIPP liner using mortar systems, for which a general building authority approval is valid,
c) GRP laminates for which a general building authority approval is valid,
d) Grouting with polyurethane (PU) or epoxy (EP) resins for which a general building authority approval is valid,
e) Installation of CIPP liner end sleeves for which a general building authority approval is valid.

Proper execution of the watertight design of the transitions must be ensured.

3.2.3.15 Restoring lateral connections

After completion of the curing process using a UV light source or steam curing, the lateral connections must be opened using camera-monitored compressed air or hydraulically operated milling robots (Annex 22).

The milling process must be controlled and monitored from the vehicle's control and monitoring room or by means of video/monitor equipment. The user must ensure that any larger residues of the hardened CIPP liner are removed from the wastewater pipe during milling; minor residues that end up in the wastewater are harmless.

The watertight restoration of lateral connections in open or closed construction must only be carried out using repair or rehabilitation methods for which general building authority approvals with the associated general type approvals for this purpose are valid.

3.2.3.16 Labelling in the manhole

The following labelling should be permanently and easily legible in the start or end shaft of the rehabilitation measure:

- Type of rehabilitation
- Designation of the pipe section
- Nominal diameter
- Composite wall thickness of the CIPP liner
- Year of rehabilitation

3.2.3.17 Final inspection and leak test

After the work is completed, the rehabilitated pipe section must be visually inspected. Check that any material residues have been removed and that there are no hydraulically unfavourable creases. No glass fibers must be exposed.

After the CIPP liner has cured, including the creation of the manhole connections and the restoration of the lateral connections, the tightness must be tested. This can also be carried out in sections.

The tightness of the renovated pipes must be checked using water (procedure "W") or air (procedure "L") in accordance with DIN EN 1610[13] (Annex 26). When testing with air, the

specifications in Table 3 of DIN EN 1610[13], test procedure LD for damp concrete pipes and all other materials must be observed. Lateral connections rehabilitated using the hat-profile technique or the injection-technique can also be tested separately for watertightness using suitable inflatable pipe plugs.

3.2.4 Testing on samples taken

3.2.4.1 General information

Circular rings or segments must be removed from the hardened circular CIPP liner or the approximately circular CIPP liner for egg-shaped sections in the non-accessible area (see specifications for "safety caps" in section 3.2.3.6) at the respective construction site (Annex 27). For wastewater pipes with egg-shaped section cross-sections that have width/height dimensions of ≥ 600 mm/900 mm, samples must be taken from the hardened CIPP liner in the area of the greatest buckling load, i.e. in the cross-sectional area, from 3 o'clock to 5 o'clock. The sampling point must then be closed again using a hand laminate of the same composite wall thickness.

If it turns out that the test pieces are unsuitable for the tests mentioned, the properties to be complied with can be checked on samples taken directly from the cured CIPP liner. For CIPP liners with egg-shaped section cross-sections, the sampling in this case must also be carried out in the non-accessible area in the cross-sectional area from 3 o'clock to 5 o'clock.

When changing the resin supplier, one complete circular ring (pipe section) must also be removed from the cured CIPP liner. The ring stiffness must be checked. During the test, the 1-minute value, the 1-hour value and the 24-hour value of the ring stiffness must be recorded. The ring stiffness test must be carried out in accordance with DIN 53769-3[15] including the creep tendency.

3.2.4.2 Strength properties

The flexural elastic modulus and the bending stress σ_{fB} (with the composite wall thickness according to section 3.1.2.1.3) must be determined on the circular rings removed.

During these tests, the 2-minute value, the 1-hour value and the 24-hour value of the bending elastic modulus as well as the 2-minute value of the bending stress σ_{fB} must be recorded. The test must also determine whether the creep tendency in accordance with DIN EN ISO 899-2[27] of

$K_n \leq 10.0\%$ for the "IMPREG liner GL16" with UP resin and

$K_n \leq 5.4\%$ for the "IMPREG liner GL16" with VE resin

is complied with in accordance with the following relationship:

$$K_n = \frac{E_{1h} - E_{24h}}{E_{1h}} \times 100$$

In addition, the flexural elastic modulus and the bending stress σ_{fB} according to DIN EN ISO 11296-4[2] are measured on the cured GRP CIPP liner or DIN EN ISO 178[20] (three-point bending test), whereby curved test bars from the corresponding circular profile or from the range of egg-shaped section cross-sections from 3 o'clock to 5 o'clock are to be used, which should have a minimum width of 50 mm in the axial direction. When testing and calculating the elastic modulus, the span measured between the support points of the test bar must be taken into account.

The determined short-term values of the elastic modulus n and the bending stresses σ_{fB} must be equal to or greater than the values specified in section 3.1.2.1.4 and section 3.1.2.1.3.

When changing the resin supplier, the short-term value, the 1-hour value and the 24-hour value of the ring stiffness must also be determined on the circular rings removed. The ring stiffness test must be carried out in accordance with DIN 53769-3[15] or DIN EN 1228[14] respectively. The creep tendency must also be determined.

[27] DIN EN ISO 899-2 Plastics – Determination of creep behaviour – Part 2: Flexural creep by three-point loading (ISO 899-2:2003); German version EN ISO 899-2:2003; Issued: 2003-10

3.2.4.3 Watertightness

The watertightness of the cured GRP CIPP liner is tested on test pieces taken from the cured CIPP liner without preliner and without inner and outer foils in accordance with the criteria of DIN EN 1610[13] must be carried out.

The test pieces can be tested either with positive pressure or negative pressure of 0.5 bar.

For the negative pressure test, the sample must be pressurised with water on one side. At a negative pressure of 0.5 bar, no water must be visible on the unpressurised side of the sample during a test period of 30 minutes.

When testing using overpressure, a water pressure of 0.5 bar must be applied for 30 minutes. Even with this method, no water leakage should be visible on the unpressurised side of the sample.

3.2.4.4 Wall thicknesses and wall structure

The wall structure according to section 3.1.2.1.1 must be checked on cut surfaces, e.g. using an optical microscope with approx. 10x magnification. In particular, the design wall thickness and composite wall thickness as well as the thickness of the pure resin layer or wear layer must be checked. In addition, the average surface area of any porous spots must be checked in accordance with DIN EN ISO 7822[28].

3.2.4.5 Physical characteristics of the cured CIPP liner

The data on density, hardness, glass content and glass surface weight specified in section 3.1.2.1.3 must be checked on the samples taken.

3.2.5 Declaration of conformity for the completed rehabilitation measure

Certificate of compliance of the executed rehabilitation measure with the provisions of the general type approval covered by this notice must be provided by the executing company with a declaration of conformity based on the specifications in the following Tables 1 and 2. The declaration of conformity shall be accompanied by documents on the properties of the process components in accordance with section 2.1.2 and the results of the tests in accordance with Tables 1 and 2.

The manager of the rehabilitation measure or a representative of the manager who is competent in the rehabilitation must be present on the construction site during the execution of the rehabilitation. They must ensure that the work is carried out correctly in accordance with the provisions of section 3.2 and, in particular, must carry out or arrange for the tests in accordance with Table 1 and arrange for the tests in accordance with Table 2. For the tests listed in Table 2, samples must be taken from the sample pipes described in section 3.2.3.4. The number and scope of the specifications made are minimum requirements.

The tests on test pieces in accordance with Table 2 must be carried out by a monitoring body recognised by the building authorities (see list of testing, monitoring and certification bodies in accordance with the state building regulations, Part V, No. 9).

[28] DIN EN ISO 7822 Textile glass reinforced plastics – Determination of void content Loss on ignition, mechanical disintegration and statistical counting methods (ISO 7822:1990); German version EN ISO 7822:1999; Issued: 2000-01

Once every six months, a sample must be taken from a CIPP liner of a completed rehabilitation measure by the aforementioned monitoring centre. The latter must also check the documentation of the designs according to Table 1 of the rehabilitation measure.

Table 1: "In-process tests"

Subject of the test	**Type of request**	**Frequency**
Visual inspection of the pipe	In accordance with section 3.2.3.1 and DWA-M 149-2[24]	Before every rehabilitation
Visual inspection of the pipe	In accordance with section 3.2.3.17 and DWA-M 149-2[24]	After every rehabilitation
Device equipment	In accordance with section 3.2.2	Every construction site
Labelling of the transport containers	In accordance with section 2.2.3	
Feed forces	In accordance with section 3.2.3.7	
Inflation pressures	In accordance with section 3.2.3.9	
Working pressures	In accordance with section 3.2.3.10.1	
Temperature level and speed of UV light source	In accordance with section 3.2.3.10.2	
Condition of the UV lamps	In accordance with section 3.2.3.10.3	
Steam temperature and exposure time	In accordance with section 3.2.3.11	
Air and water tightness	In accordance with section 3.2.3.17	

Table 2: "Tests on test pieces"

Subject of the test	Type of request	Frequency
Short-term bending elastic modulus, short-term bending stress and creep tendency on pipe cut-outs or on circular rings	In accordance with sections 3.2.4.1 and 3.2.4.2	Every construction site, at least every second CIPP liner
Glass content without inner and outer protective film	In accordance with section 3.2.4.5	
Density and hardness of the sample without inner and outer protective film	In accordance with sections 3.1.2.1.3 and 3.2.4.5	
Watertightness of the sample without inner and outer protective film	In accordance with section 3.2.4.3	
Wall thicknesses and wall structure	In accordance with section 3.2.4.4	
Short-term elastic modulus (short-term ring stiffness) and creep tendency on pipe sections or cut-outs	In accordance with sections 3.1.2.1.3 and 3.2.4.2	With each change of resin supplier with declaration of the resins
Resin identity by means of IR spectroscopy	In accordance with section 2.1.2	With each change of resin supplier with declaration of the resins
Creep tendency on pipe sections or cut-outs	In accordance with section 3.2.4.2	If the short-term elastic modulus specified in section 3.1.2.1.4 is not reached and at least 1 x CIPP liner per half-year

The test results must be recorded and analysed; they must be submitted to the Deutsches Institut für Bautechnik on request.

Ronny Schmidt
Head of unit

Notarised
Graeber