37TH INTERNATIONAL NO-DIG FLORENCE 2019

Fortezza da Basso • FLORENCE (Italy)

30th September • 2nd October 2019

Renovation of sewerage networks under pressure with cured-in-place pipes; the new RSV leaflet 1.2

Dr. Eng. Susanne Leddig-Bahls
IQS Engineering AG

Contents

RSV leaflet 1.2
„Renovation of sewage pressure lines with on-site curing pressure hose liners“

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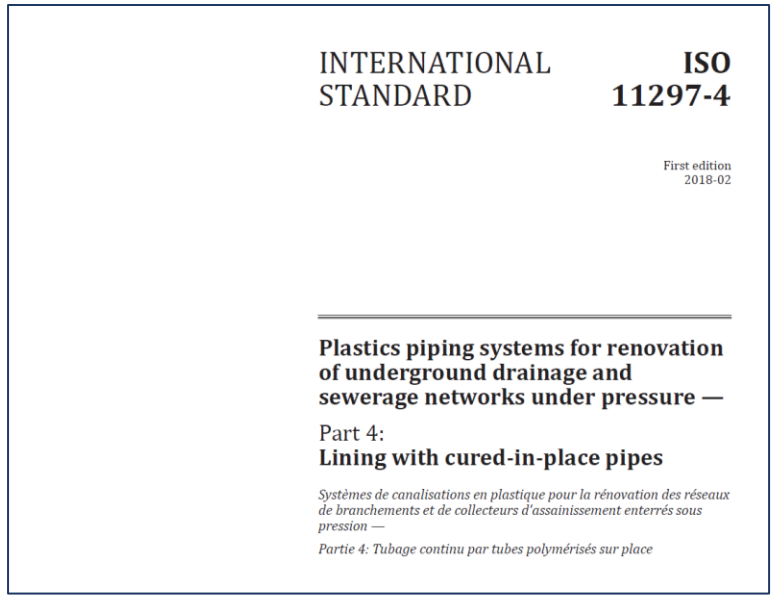
RSV Rohrleitungssanierungs-verband e.V.
Der Zukunft verpflichtet

Renovation of sewage pressure pipelines with on-site curing pressure hose liners; the new RSV leaflet 1.2

1. Background and Objectives

Status Quo:

- *Lining with cured-in-place pipes* successfully established in the pipe rehabilitation market for more than 45 years
- Extensive regulation of the technology in the gravity sewer field
- Hardly any controls in the pressure pipeline area



INTERNATIONAL STANDARD **ISO 11297-4**

First edition 2018-02

Plastics piping systems for renovation of underground drainage and sewerage networks under pressure —

Part 4:
Lining with cured-in-place pipes

Systèmes de canalisations en plastique pour la rénovation des réseaux de branchements et de collecteurs d'assainissement enterrés sous pression —

Partie 4: Tubage continu par tubes polymérisés sur place

ISO 11298-4 applies to the rehabilitation of drinking water pipelines

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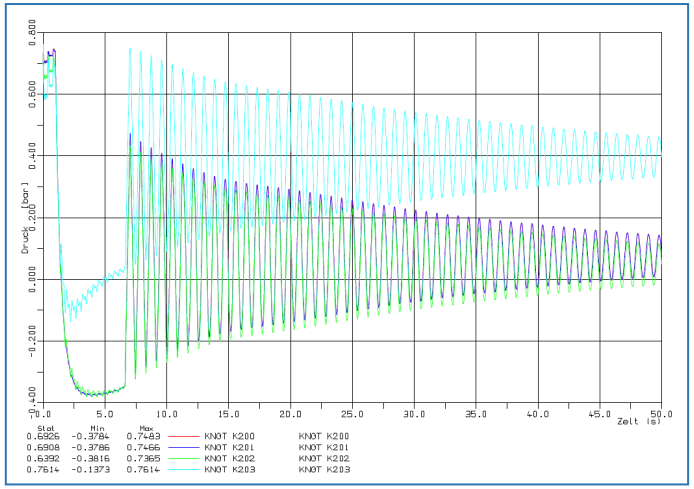
Pressure pipelines - a special challenge

- Decommissioning for cleaning and inspection only in exceptional cases
- Often long distances without inspection openings/ access

→ Comprehensive condition data for rehabilitation planning is often lacking

- Switching operations of the waste water pumps can trigger a *pressure surge* in the line.



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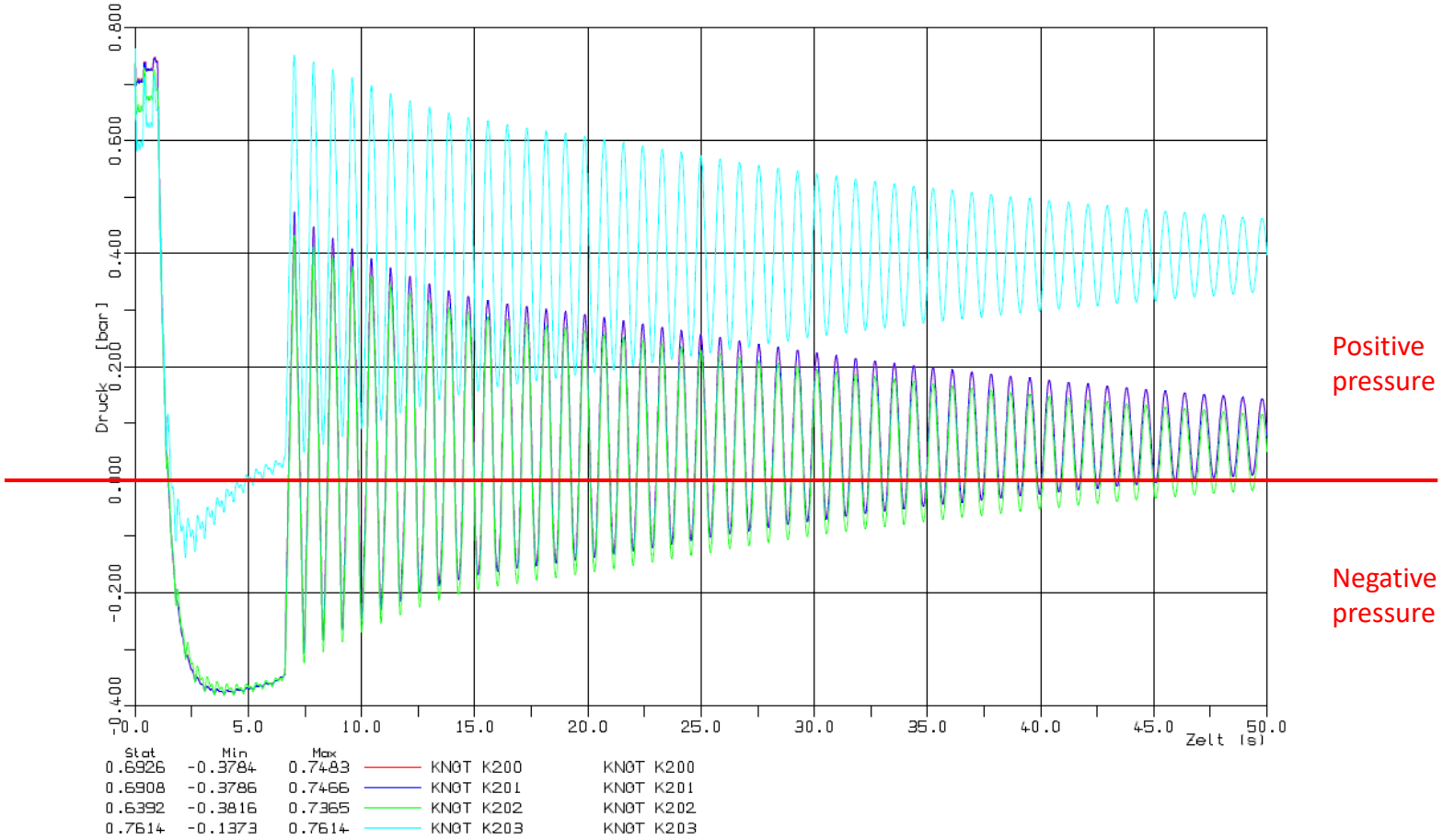
Renovation of sewage pressure pipelines with on-site curing pressure hose liners; the new RSV leaflet 1.2

1. Background and Objectives



Positive pressure

Negative pressure

Example from the city of Hamburg for a typical vibration curve of a pressure surge wave (from pressure surge calculation)

Pressure hose liner – As a system in particular demand

- Increasing number of failures in pressure pipelines
- Technical service life of many pipelines achieved

Inner corrosion

Pressure hose liner – As a system in particular demand

- Increasing number of failures in pressure pipelines
- Technical service life of many pipelines achieved

Pitting corrosion

Longitudinal crack

Pressure hose liner – As a system in particular demand

- Increasing number of failures in pressure pipelines
- Technical service life of many pipelines achieved
- The requirements for pressure hose liners are significantly higher than " simply " the design of a gravity fed liner for the load case internal pressure.

I. Pressure hose liner must withstand pressure shock waves (positive and negative pressure)

II. Pressure hose liner must enable permanent, safe integration into the existing network and can only be considered as a pressure hose liner system.

III. The liner must be installed quickly for immediate recommissioning (economic efficiency) and safely (high damage potential for pressure pipes).

Objectives of the leaflet

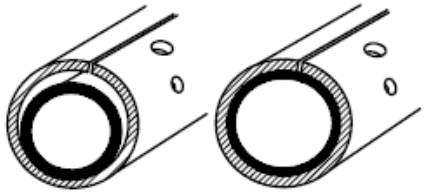
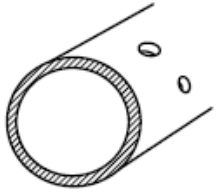
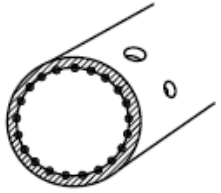
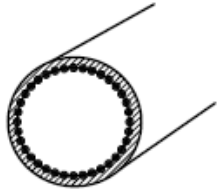
- Presentation of the normative basis
- Requirements for materials, techniques and processes
- Basics for planning, execution and testing
- Firstly, the definition of the pressure hose liner system:

  Pressure hose liner along with its links and connections to the pressure pipeline network
- Quality assurance requirements based on typical operating conditions in the pressure pipe system

Renovation of sewage pressure pipelines with on-site curing pressure hose liners; the new RSV leaflet 1.2

2. Scope of the Leaflet

- Pressure hose liner of classes A, B, C in acc. with EN ISO 11295

Class A		Class B	Class C	Class D
				
loose-fit	close-fit	inherent ring stiffness	relies on adhesion	relies on adhesion
Independent		**Interactive**		
Fully structural		**Semi-structural**		**Non-structural**
Lining with continuous pipes				This International Standard is not applicable
	Lining with close-fit pipes			
	Lining with cured-in-place pipes			
			Lining with adhesive-backed hoses	
—	—	Lining with sprayed polymer material	—	

NOTE 1 Lining with drawn-in hoses is still to be classified, as the development of product standards for these technical families is still pending.
NOTE 2 The dots in the images for Classes C and D represent the gluing connections

2. Scope of the Leaflet

- Pressure hose liner of classes A, B and C in accordance with EN ISO 11295

  Class A: independent, fully structural, close-fit

  Class B: inherent ring stiffness, interactive, semi-structural

  Class C: based on an adhesive bond, interactive, non-structural

- The class A liner assumes all loads from inside and outside.
- Class B and C liners cannot, by definition, withstand all occurring loads alone ("supports" itself radially on the old pipe).

Special features to be taken into account for sewage pressure pipelines e.g.

Condition Detection

- Special attention must be paid to: hole diameter, socket gap widths, offsets, bends, internal coatings
- Specifications for the static system: self-supporting or co-supporting? Worsening of the condition of the host pipe possible, e.g. due to external corrosion?
- Pre-existing damages such as cracks, for example, occurred mechanically or due to operational problems (lack of ventilation)?→ If necessary pressure surge calculation!
- if necessary, wall thickness measurement of the pipeline (for class B)

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Preparation of the host pipe

- Requirements for cleaning dependent on condition and material of the host pipe

Surge rinsing, pigging, high water pressure, extreme high water pressure, mechanical cleaning methods

- Choice of the cleaning method depending on the cleaning objective

Class A and B:	*free from obstruction and incrustation*
Class C:	*additionally free of separating substances (adhesive free, "metallic bright")*

- If necessary, arrangement of cleaning pits, which may be used later for installation.

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Information about the host pipe

- Minimum info for the host pipe:

  material, age,
  existing interior/exterior protection,
  Nominal pressure (PN),
  DN (d_i, d_a), DN-change,
  length, bends,
  mountings (e.g. valves, fittings, connections),
  design of the pipe connections (tensile strength, plugged in, thrust blocks)

- if possible, pipe routing in height and position (always necessary for pressure surge calculation, see below)
- bedding of the host pipe, soil parameters for semi- and non-structural solutions

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Operational boundary conditions

- The relevant operational parameters are the maximum operating pressure and the maximum rated pressure.
- Maximum operating pressure usually occurs as a result of pressure surges.

- Pressure surge calculation:

  for long pipe lengths >100 m and critical flow velocities necessary,

  Information on type of pump switching and number of switching operations per time unit required

- Determination of existing installations (aeration and ventilation valves, gate valves etc.) and clarification of its function

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Static requirements

Which liner class should be used?

Classification acc. to DIN EN ISO 11295	Load case acc. to DWA A 143-2	Impacts from inside	Impacts from outside
Class A Fully structural **	**Load case II** Host pipe does not support in the long term	▪ Internal pressure (boiler formula as well as bridging of socket gaps and holes) ▪ Negative pressure	▪ External water pressure ▪ Earth and live loads*
Class B, C Semi-structural	**Load case I** Host pipe supports	▪ Internal pressure (only bridging of socket gaps and holes) ▪ Negative pressure	▪ External water pressure
			Taking into account existing imperfections

** Depending on the condition, the host pipe does not bear the internal pressure in the long term, but as an host pipe-ground system, it can also carry the ground pressure and live loads, so that these do not have to be taken into account in the liner statics.*
*** in straight sections of pipe*

Preparation of preliminary statics and determination of required wall thickness for tendering procedure

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Furthermore should be taken into account

- the possible flow control (accumulation times, necessary replacement pipe, decommissioning concept),
- the planned renovation procedure (arrangement of excavation pits, installation options, etc.),
- Information on quality testing (material testing, optical inspection, pressure testing, etc.)

In addition, the RSV leaflet provides information for a safe tendering procedure: Concrete naming of essential information for building specifications or service specifications.

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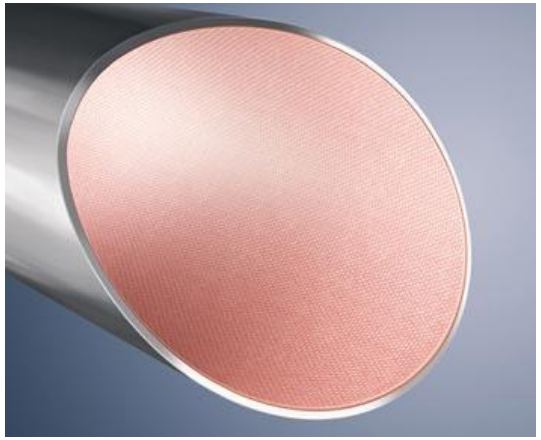
Renovation of sewage pressure pipelines with on-site curing pressure hose liners; the new RSV leaflet 1.2

4. Pressure Hose Lining Methods

- Procedures differ on the market in terms of liner materials, areas of application, technology



Fabric hose
very high flexibility

Glass liner
very high strength

Glass fibre reinforced needle felt liner
combines flexibility and strength

4. Pressure Hose Lining Method

- Technical overview

	Fabric hose	Needle felt liner	Hose liner with fabric hose layer	Glass fibre reinforced needle felt liner	Glass fibre liner
Classification EN ISO 11295 (design dependent)	C	A, B	A, B, C	A, B, C	A, B
DN-Range [mm]*	DN80-DN1200	DN100-DN1600	DN100-DN1000	DN100-DN1600	DN150-DN1500
Composite-thickness [mm]*	2 to 5	4 to 30	4 to 25	5 to 15	4 to 15
Resin type	EP	EP, UP	EP	EP, UP	UP, VE
Installation method	Inversion	Inversion, Combination Pulling in/ Inversion			Pulling in
Curing method	Warm curing (Water/ steam) Ambient temperature	Warm curing (Water/ Steam)			UV-Curing Combination-curing
Bend mobility (depending on radius)*	≤ 45° (larger bends with radii > 6D possible with restriction)				≤ 10°

** The stated values are typical areas of application; individual characteristic values for the various pressure hose liners can be found in the manufacturer's data.*

Renovation of sewage pressure pipelines with on-site curing pressure hose liners; the new RSV leaflet 1.2

4. Pressure Hose Lining Method

- System diversity offers flexibility...

Liner inversion
and steam curing

Liner pull-in
and UV-curing

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5. Connection and Joining Techniques

- Renovated pressure pipe must be handed over ready for connection; pressure pipe renovation always includes connection and joining techniques
- Integration into the pressure pipe network:
  - I. Connection via the host pipe
  - II. Connection via a fitting
  - III. Connection via the cured-in-place pipe (pressure hose liner)

Renovated pipe section with spigot ends that can be connected or flange connections in accordance with EN 1092-1

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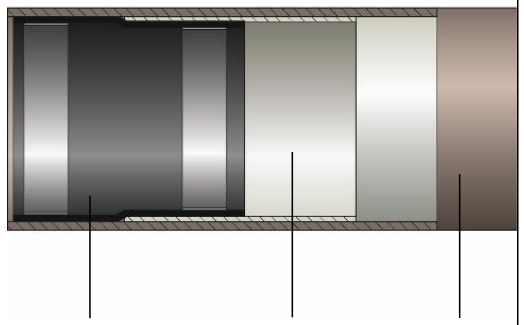
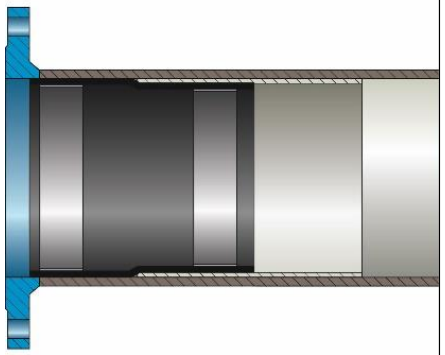
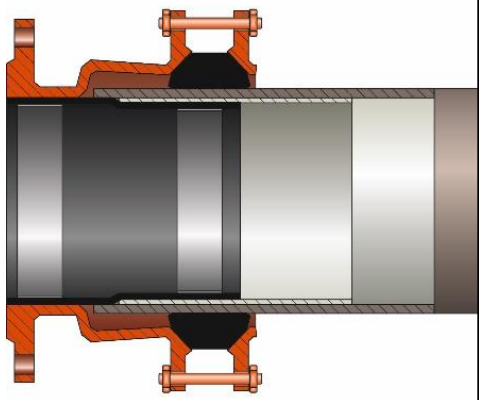
5. Connection and Joining Techniques

I.Connection via the host pipe

Host Pipe - spigot end	Welding neck flange	Multi-range coupling
		

- host pipe end as connecting element
- liner back cut in the host pipe and sealing by use of liner end seal (LES)
- for class C also without LES

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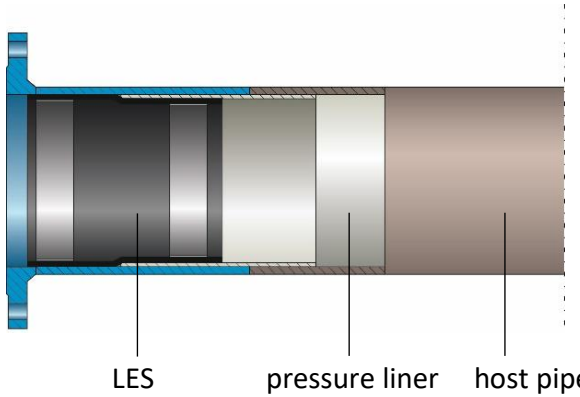
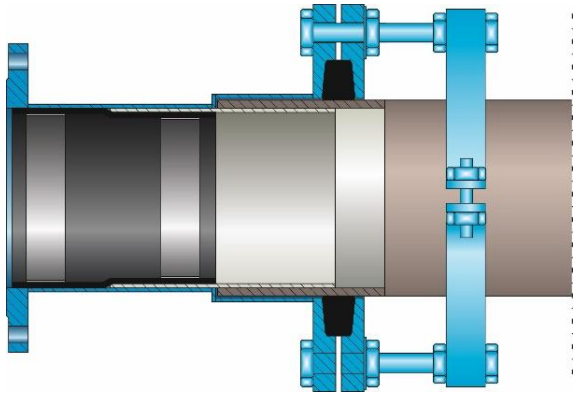
5. Connection and Joining Techniques

II. Connection via a fitting

New pipe element with flange or spigot end	Special flange with tension-proof coupling
	

- New pipe fitting with same Di positioned before liner installation
- Liner back cutting and sealing by use of LES

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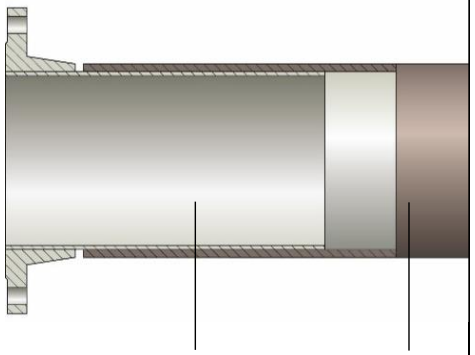
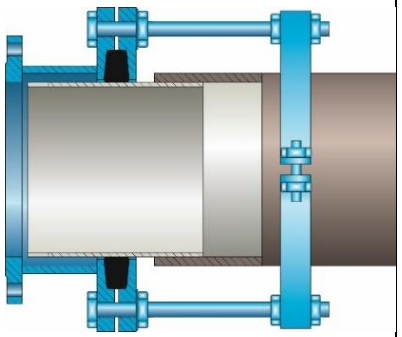
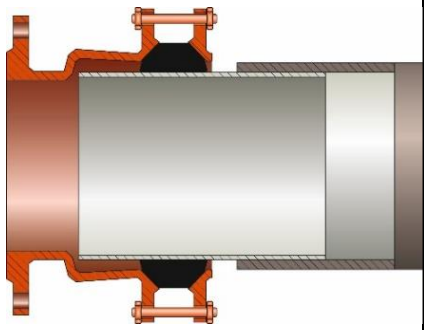
III. Connection via a pressure hose liner

GRP-Flange	Special flange with tension-proof coupling	Multi-range coupling
		

- For class A direct application of GRP flanges or mechanical couplings on the liner
- Sealing of the trimmed edge

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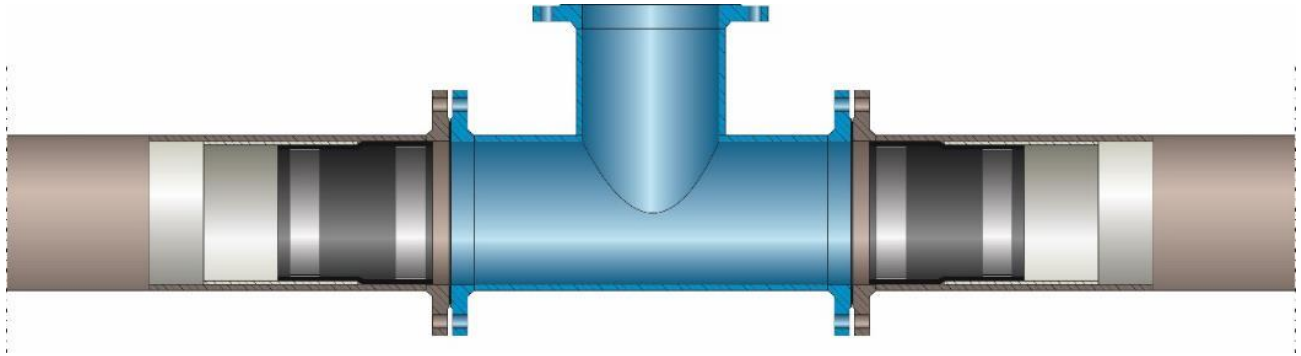
5. Connection and Joining Techniques

- Connection technology for valves such as stop valves, vents:

  a) Remove the valves and insert a pipe piece or support hose for liner installation.

  b) Separation of the cured pressure hose liner and connection of the pipe ends (see types I, II, III)

  c) Installation of the new valve



6. Requirements for the Procedure

- Increased demands for the end product and therefore also for
  a) the materials (resin system, carrier material),
  b) the technical equipment (dosing, mixing, impregnation, installation, curing),
  c) the execution of construction work
  d) the suitability test
  e) quality control of the rehabilitation systems

- Extensive monitoring and documentation of liner production,
- Proof of complete curing on the outer laminate (data collection between host pipe and liner)

Suitability tests of the pressure hose liner system

- Type tests of the cured-in-place pipes in accordance with **EN ISO 11297-4**

Tensile and compression tests, Internal pressure tests (short and long term), 10.000h test etc.

[IMA]

[SBKS]

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Suitability tests of the pressure hose liner system

- Type tests of the cured-in-place pipes in accordance with EN ISO 11297-4
- System verification of liner and connection technology by means of the **DLT method - Stress test for pressure pipes** (load alternation test)

[IB Siebert & Knipschild]

Simulation of the dynamic loads during pressure surges (approx. 10 bar to -0.9 bar)

Has been included in the DIBt test program.

cf. speech of Andreas Haacker NoDig on 1st October 2019

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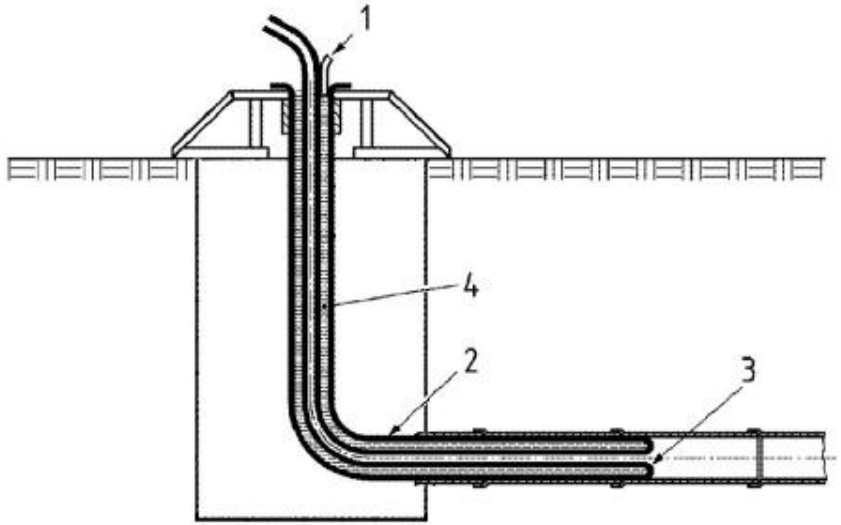
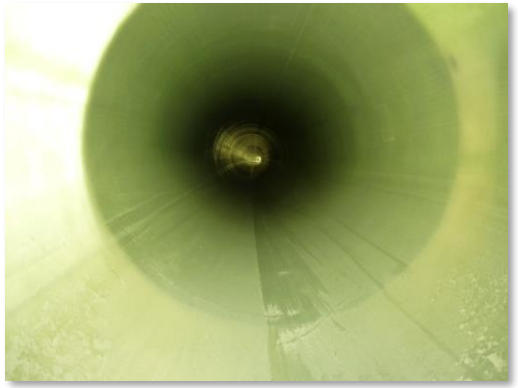
7. Rehabilitation Process

This leaflet provides specifications for

- Construction site scheduling,
- Preparatory work,
- Installation of the liner,
- Final works.



8. Quality Control of the Final Product



Quality control of the final product includes

- Optical Inspection

- Pressure Testing

  Class A and B: acc. to EN 805 und DVGW-W 400-2

  Class C: acc. to DVGW GW 327 (A)

- Quality inspection of material samples taken on site

  Class A and B: Checking the material properties acc. to DWA-A 143-3 (Section 7.2)

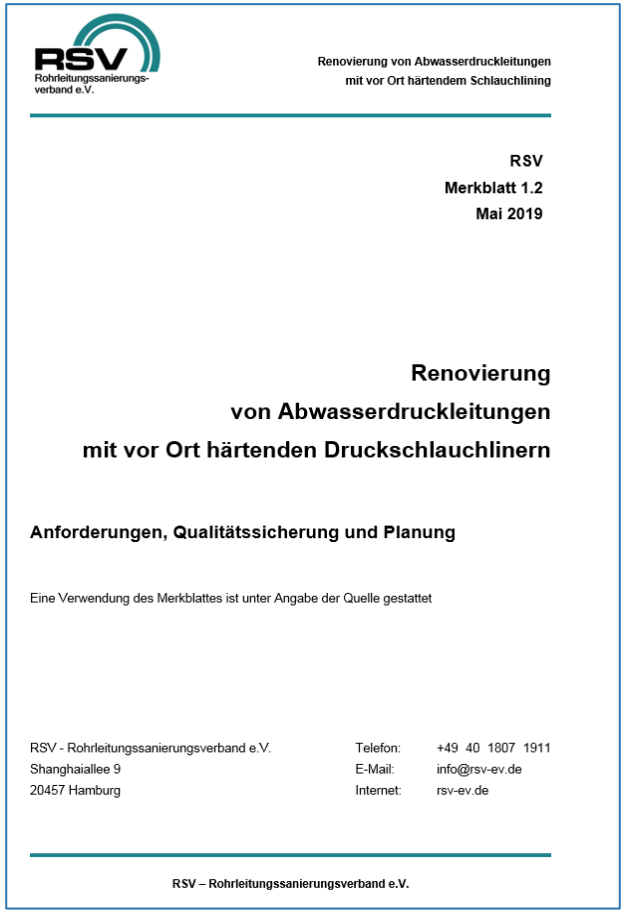
  Class C: Check of bonding (peel test) acc. to DVGW GW 327

Renovation of sewage pressure pipelines with on-site curing pressure hose liners; the new RSV leaflet 1.2

9. Summary and Outlook

The RSV leaflet 1.2 *"Renovation of sewage pressure pipelines with on-site curing pressure hose liners"* closes gaps in existing regulations and provides practical information for all those involved in the project and for all project phases.

→ **Published in German in May 2019!**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Renovierung von Abwasserdruckleitungen
mit vor Ort härtendem Schlauchlining

RSV
Merkblatt 1.2
Mai 2019

Renovierung
von Abwasserdruckleitungen
mit vor Ort härtenden Druckschlauchlinern

Anforderungen, Qualitätssicherung und Planung

Eine Verwendung des Merkblattes ist unter Angabe der Quelle gestattet

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RSV – Rohrleitungssanierungsverband e.V.

The RSV working group 1.3 *"Renovation of drinking water pipes with on-site curing pressure hose liners"* will begin its work at the start of 2020. **We are open for your ideas and requirements to be considered.**

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Thank you very much for your attention!

Chairwomen of the RSV Working Group 1.2

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