Inspection and Condition Assessment of Pressure Pipes

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1: Survey - Orientation

2: Structural reliability

3: Operational reliability

4: Conclusion and outlook

Objectives of the project

Project Objectives :

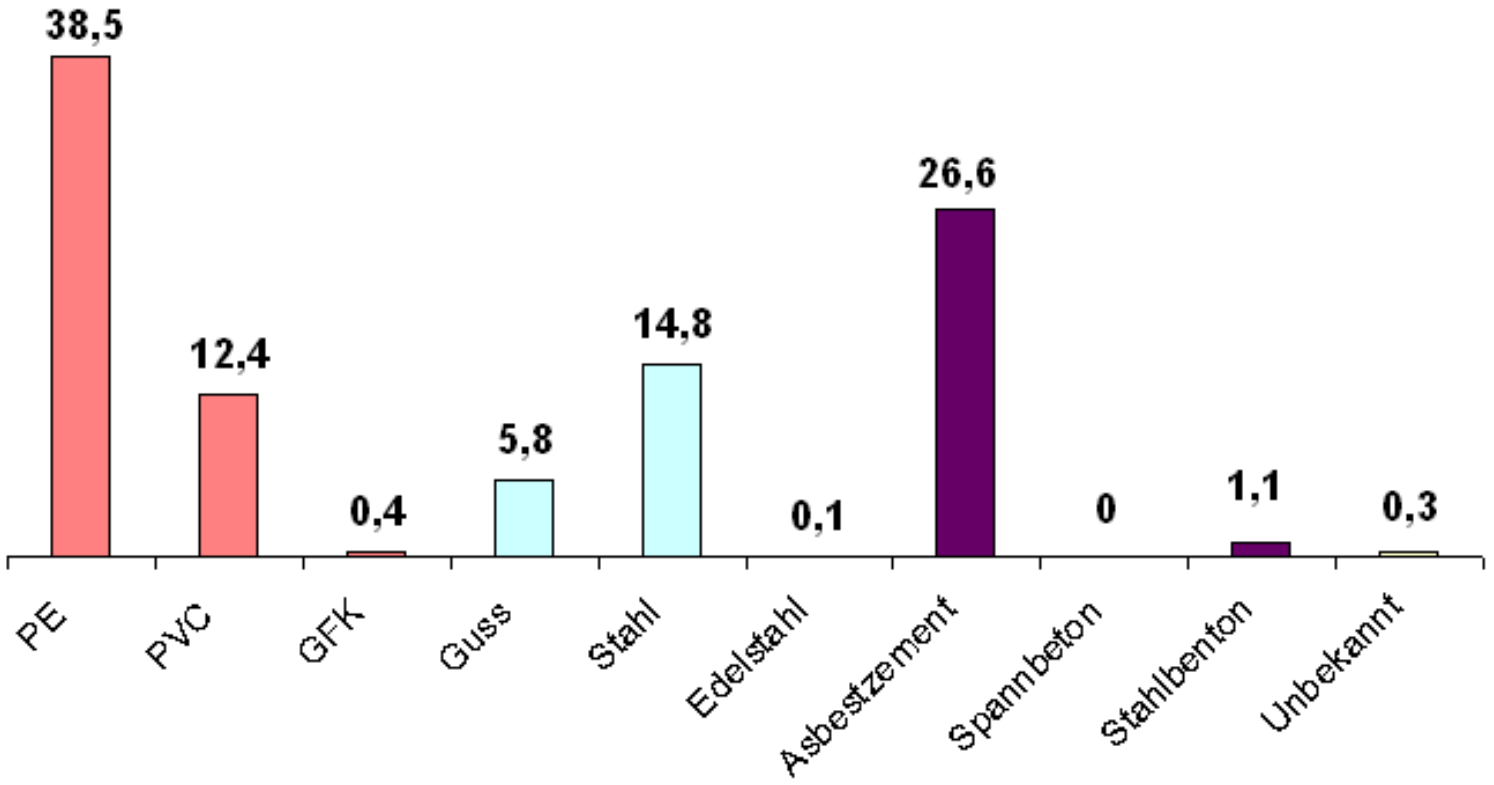
- **Market Overview Technology**
- **Overview Damage Types and Images**
- **Recommendations for State Detection**
- **Notes on Inspection-Oriented Planning**

Benefit and economic !

Survey - completed questionnaires

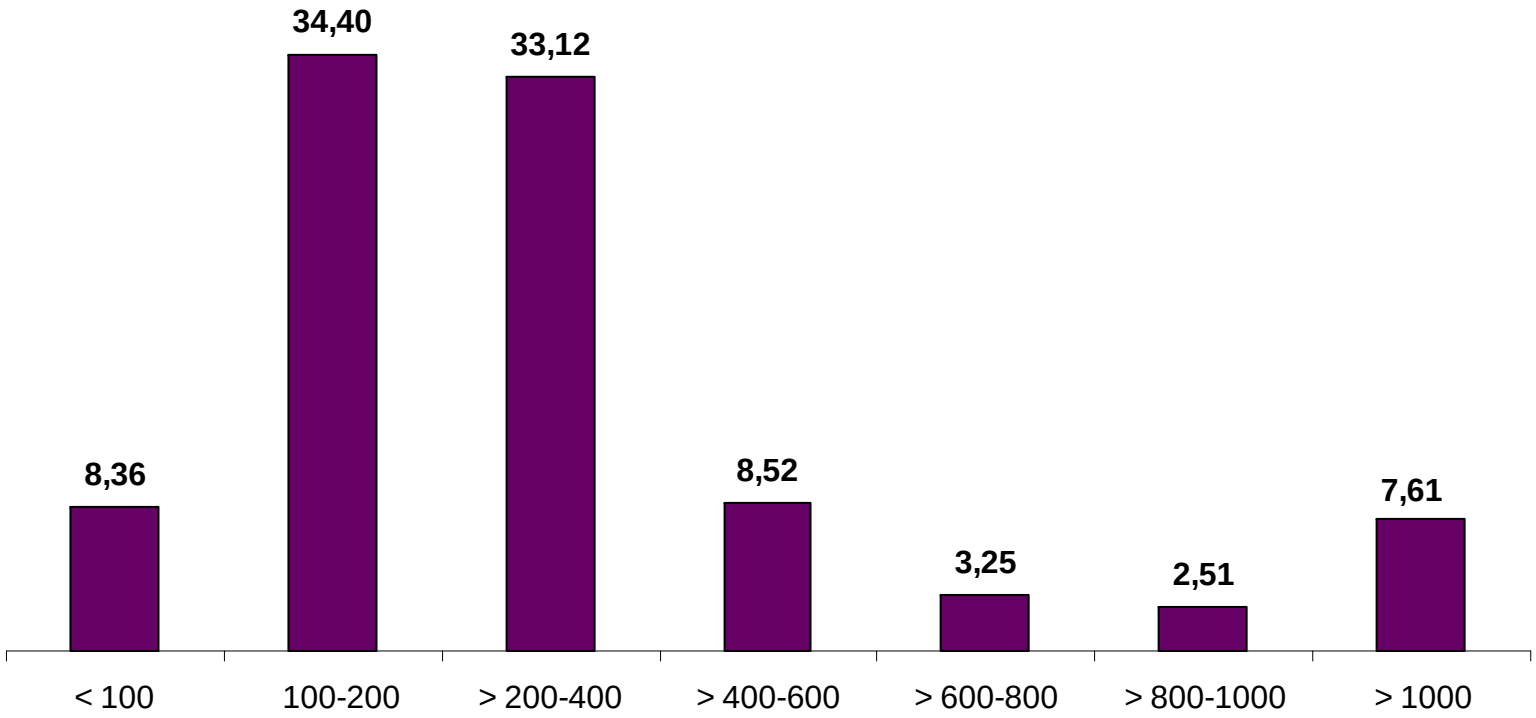
22 Network Operator	Network [km]	PP [km]
Technische Werke Emmerich GmbH	228	82
Abwasserbetrieb der Stadt Billerbeck	85	13
Stadt Rietberg	276	47
Emschergenossenschaft	308	100
Lippeverband	220	120
Gemeinde Holzwickede	100	7
Amt für Stadtentwässerung Hemer	189	9
Gemeindewerke Herzebrock-Clarholz	200	110
Stadtentwässerung und Umweltanalytik Nürnberg	1.455	25
Gemeinde Möhnesee	125	12
Technische Betriebe Leverkusen	650	24
Abwasserbetrieb Erkelenz	331	40
Entwässerung Stadt Witten	376	12
Göttinger Entsorgungsbetriebe	1.300	4
Stadt Stuttgart - Stadtentwässerung	1.748	4
Zweckverband Ostholstein - Entwässerung	820	338
Stadt Recklinghausen	430	23
Wirtschaftsbetrieb Porta Westfalica	420	29
Abwasserwerk der Stadt Bad Honnef	126	8
Landeshauptstadt Kiel Stadtentwässerung	1.200	67
Stadtbetrieb Abwasserbeseitigung Lünen AöR	335	10
Abwasserbetrieb Olpe	190	13
	11.112 km	**1.097 km**

Pressure lines – Material [%]



21 Betreiber, rd. 900 km

Pressure lines – Inside Diameter [%]



21 Operators, rd. 900 km

Inventory Data – What we know ?

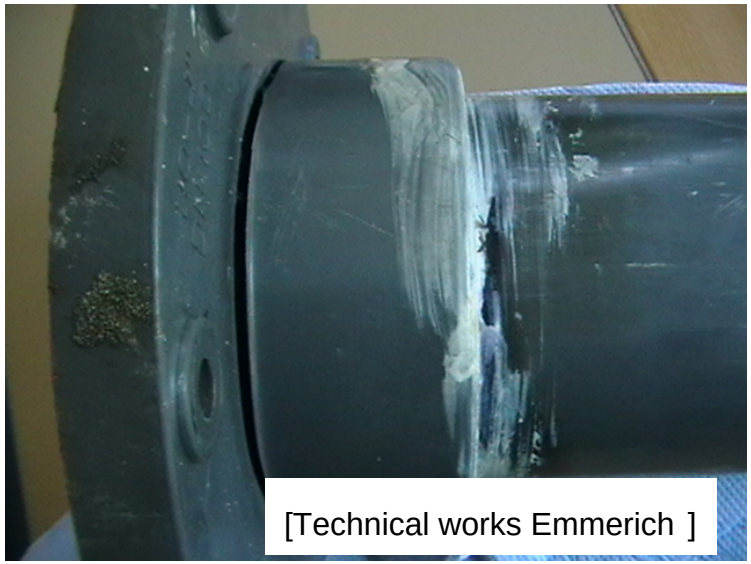
As a rule, known	often known	often unknown
-Construction year -Material -Nominal Diameter -Start and starting point (site inspection manholes) -More connectee (Approximate) location	-Flow rates -Approximate height profile -Previous damage and repairs	-Exact location -Bows - Location and design -Height profile and pressure conditions -Corrosion protection in/outside -Original wall thickness -state

Types of Damage

PE/PVC

- Faulty Connection
- Deformations
- Longitudinal Cracks
- Ring Cracks
- Material Defects / Fatigue
- Leakages (Episode)
- (Damage by third parties)

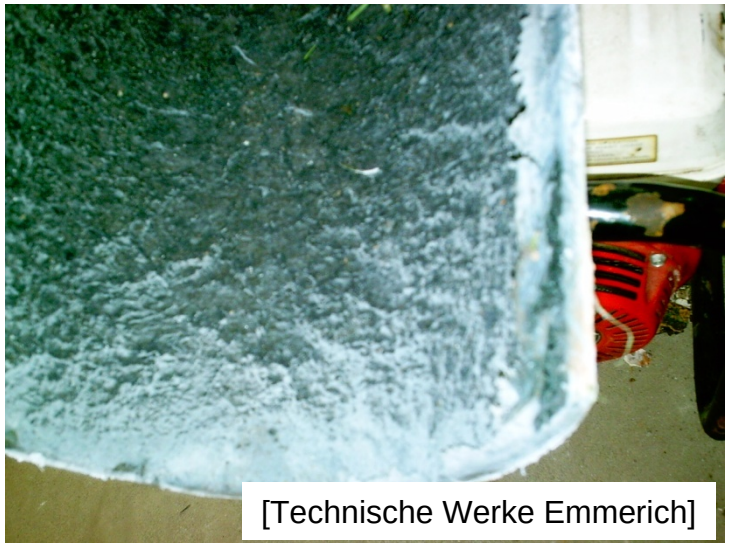
[Draining Witten]



[Technical works Emmerich]

Asbestos cement

- Corrosion (inside/outside)
- Wall Thickness Loss / Holes
- Cracking
- Body Formation
- Leakages (Episode)
- Abrasion
- (Damage by third parties)



[Technische Werke Emmerich]

[ZVO]

Steel

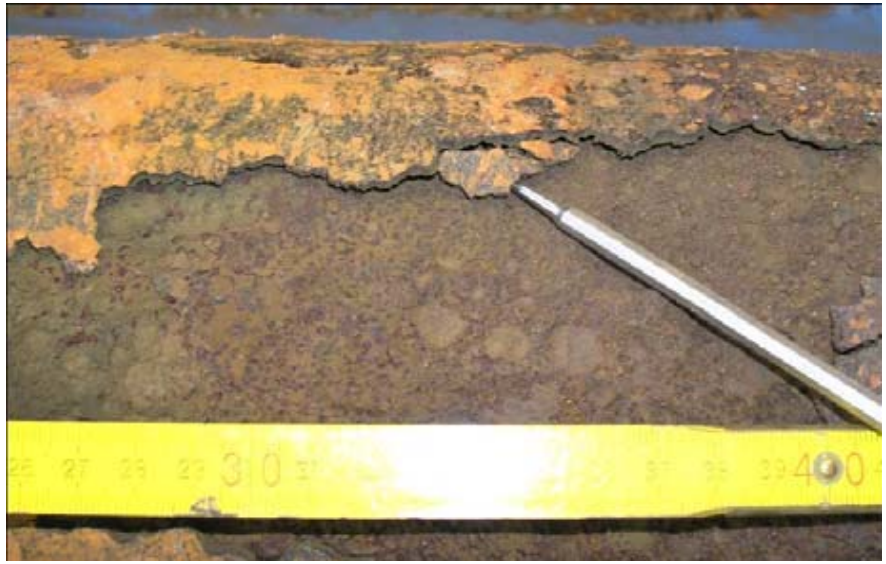
- Corrosion inside/outside
  - Surface-Corrosion
  - Troughs-Corrosion
  - Hole-Corrosion
  - Grain-Corrosion
- Leaking Connections
- Longitudinal Crack
- Circular Crack
- Deformation
- Abrasion of Corrosion Coating
- (Damage by third parties)

[Stadtentwässerung Nürnberg]

Cast

- Corrosion innen/außen
  - Surface-Corrosion
  - Troughs-Corrosion
  - Hole-Corrosion
  - Grain-Corrosion
  - Gaphitization
- Leaking Connections
- Transverse Fracture
- Shell Breakage
- Longitudinal crack
- circular Crack
- Deformation
- Abrasion of Corrosion Coating
- (Damage by third parties)

[Stadtentwässerung Nürnberg]



Common Damagee in Pressurised pipes

	PE/PVC	Asbestos-cement	Steel	Cast
Cracks (long., circular,…)	X	X	X	X
Leaking joint	X	X	X	X
Deformation	X	X	X	X
Corrosion		X	X	X
Abrasion		X	X	X
Third-party damage	X	X	X	X

Presentation plan

1: Survey - Orientation

2: Structural reliability

3: Operational reliability

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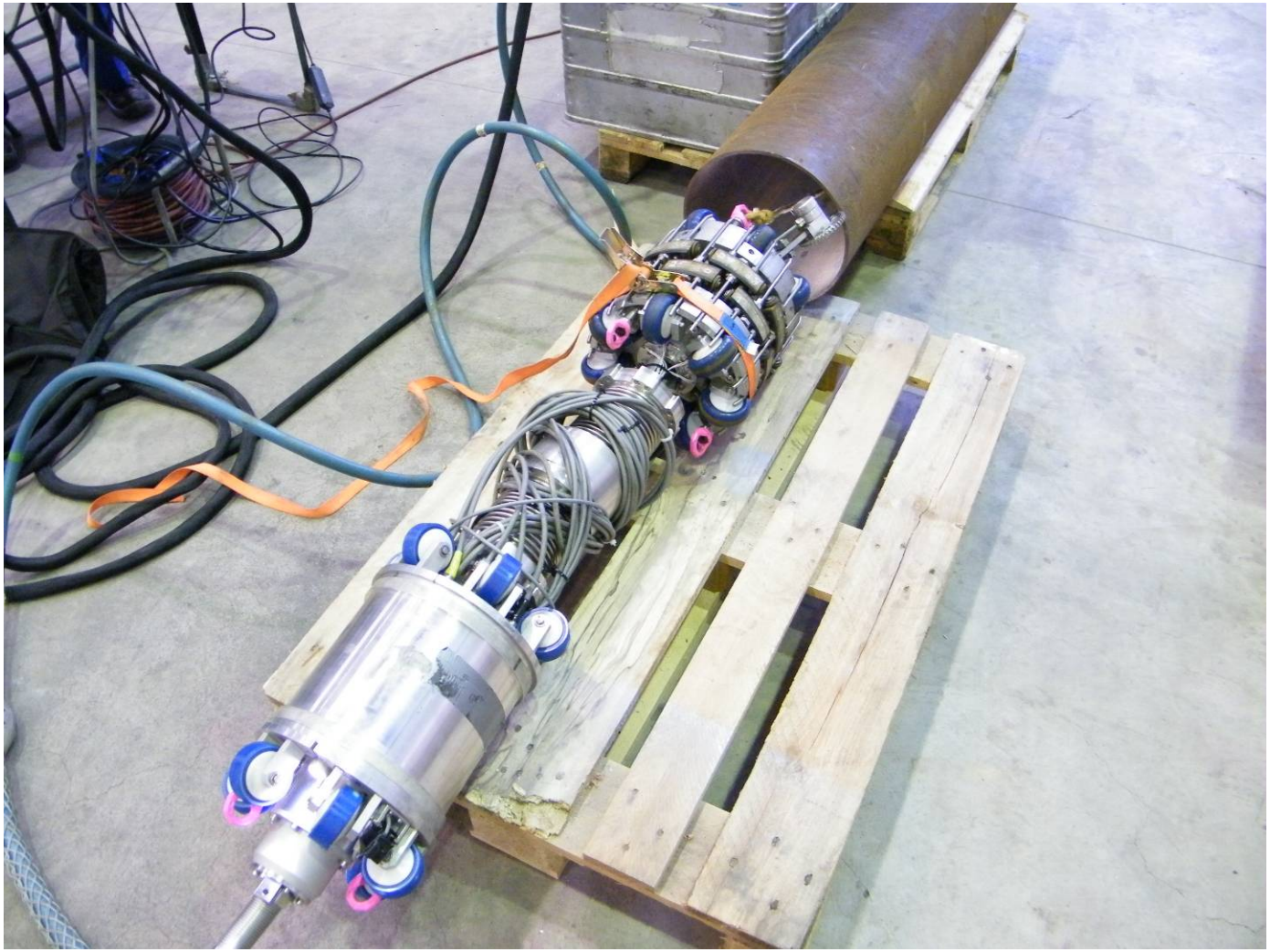
Inside inspection

- Electromagnetic Methods (pig, robot)
- Ultrasonic Method (pig, robot)
- Mechanical Measurement Geometry (pig)
- Acoustic Leak Detection (pig, Smart Ball)
- Laser Surveying (trolley camera, robot)
- Optical Methods (trolley camera, tow camera, robot)
- Georadar (additional module for trolley camera)

Outside inspection

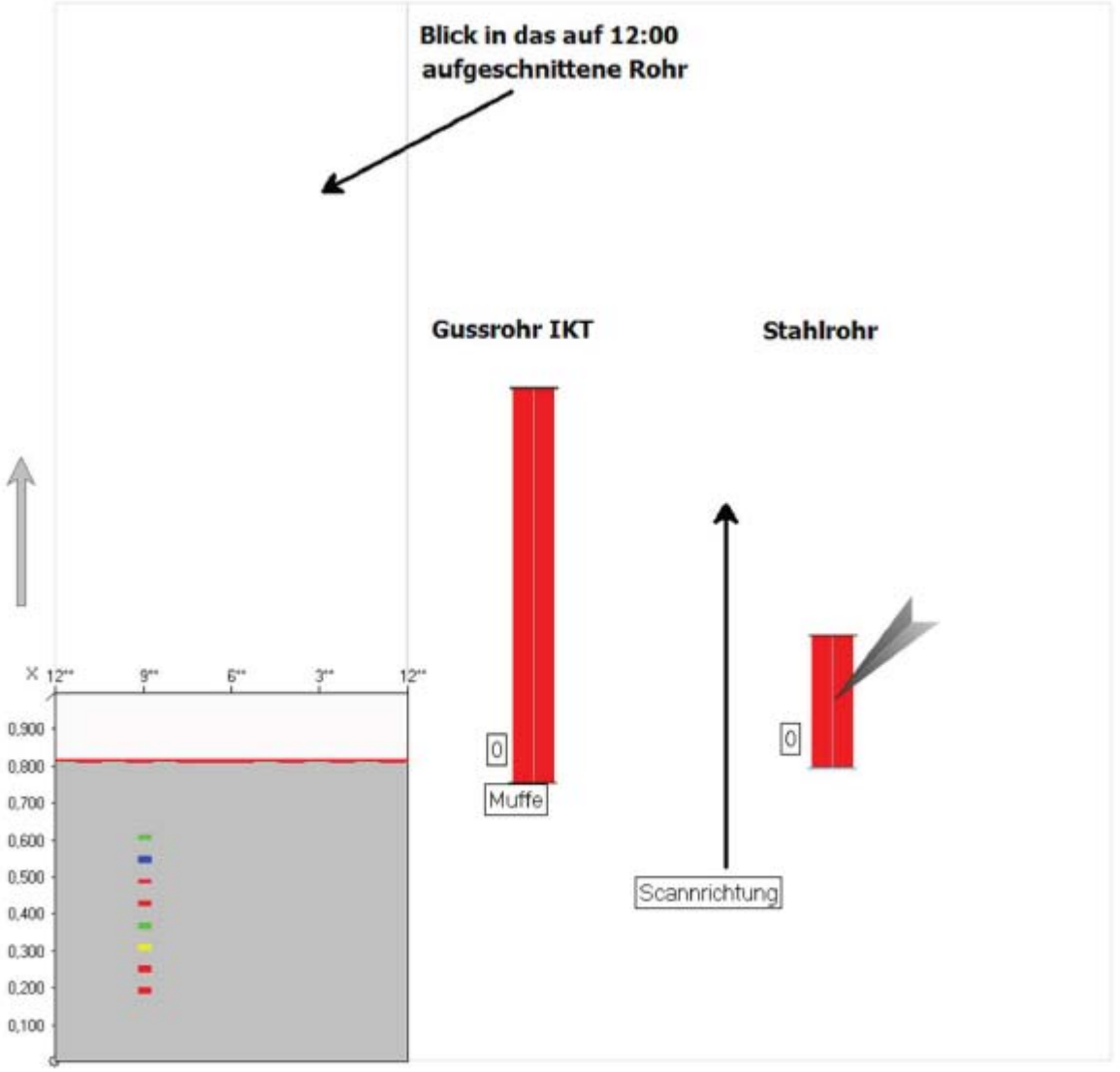
- Elektromagnetic
- Ultrasound
- Acoustic Leak Detection
- Visual Inspection
- Thermography
- Georadar

SLOFEC, Applus RTD (Steel – Cast)

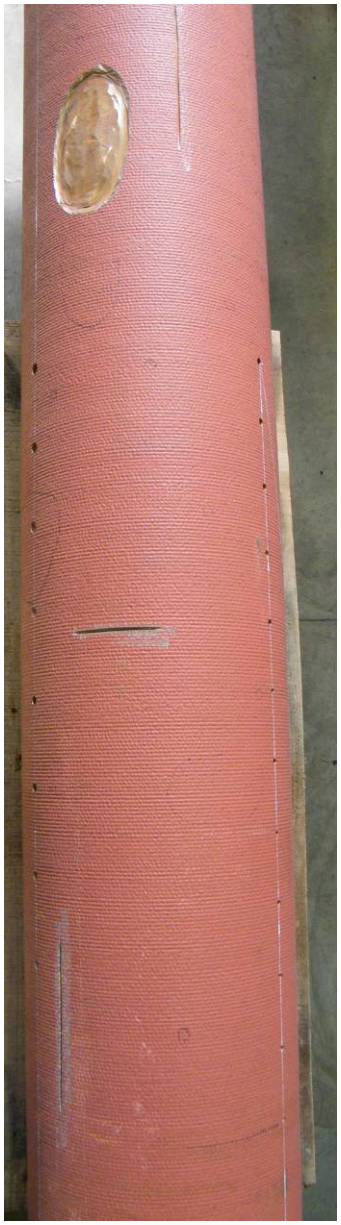


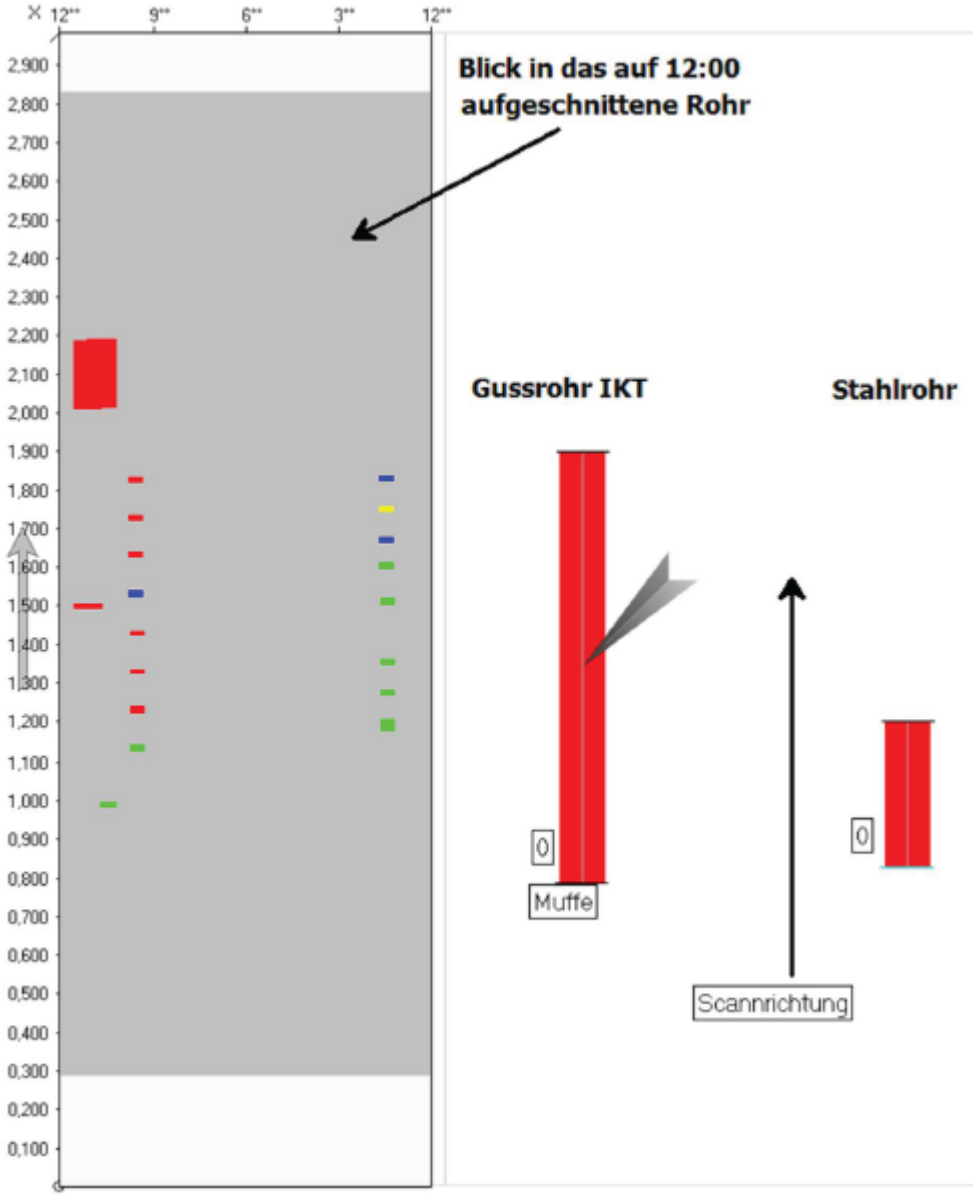
[Applus RTD]

Technology – Phase 2: Slofec/Georadar



Technology – Phase 2: Slofec/Georadar





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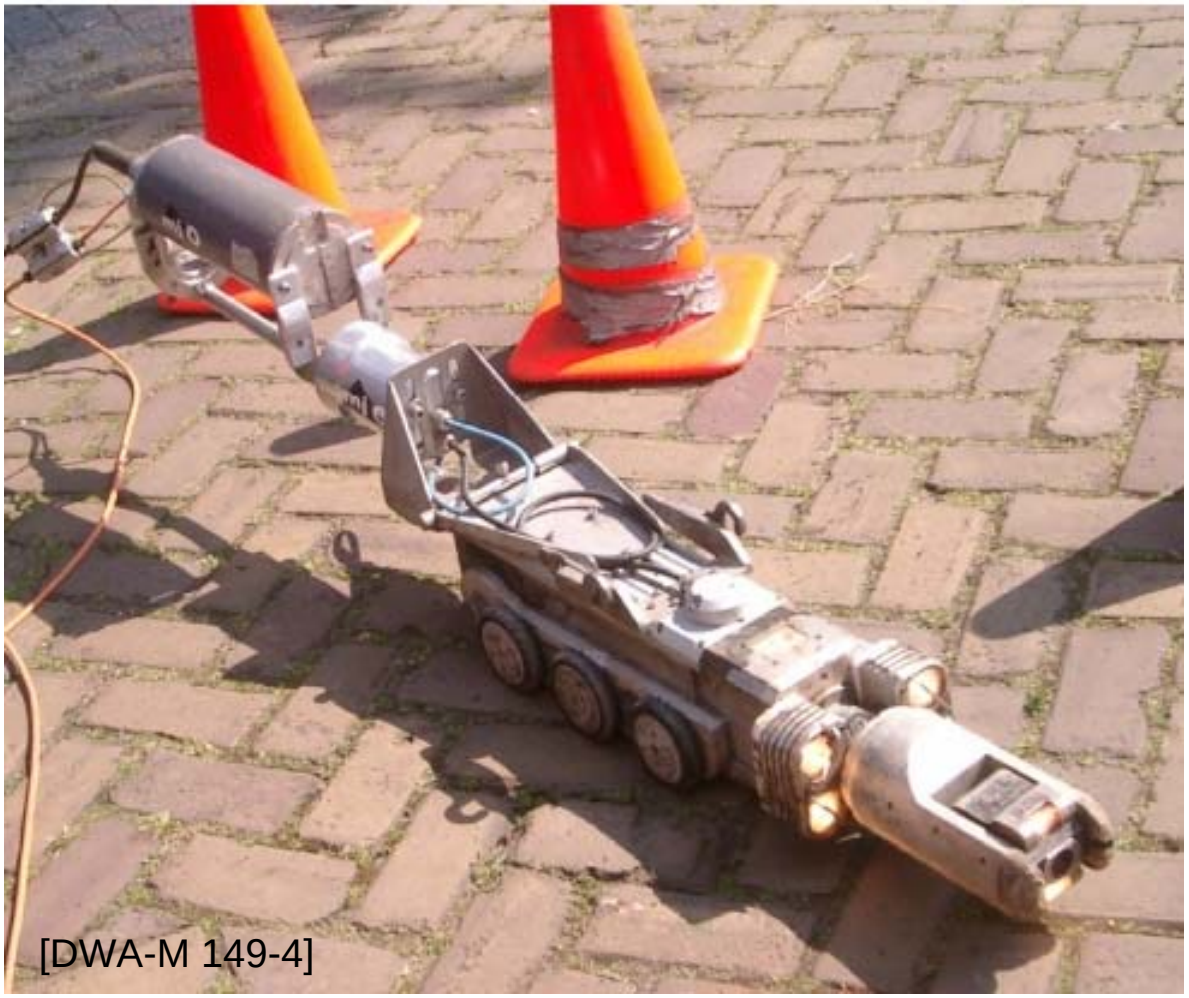
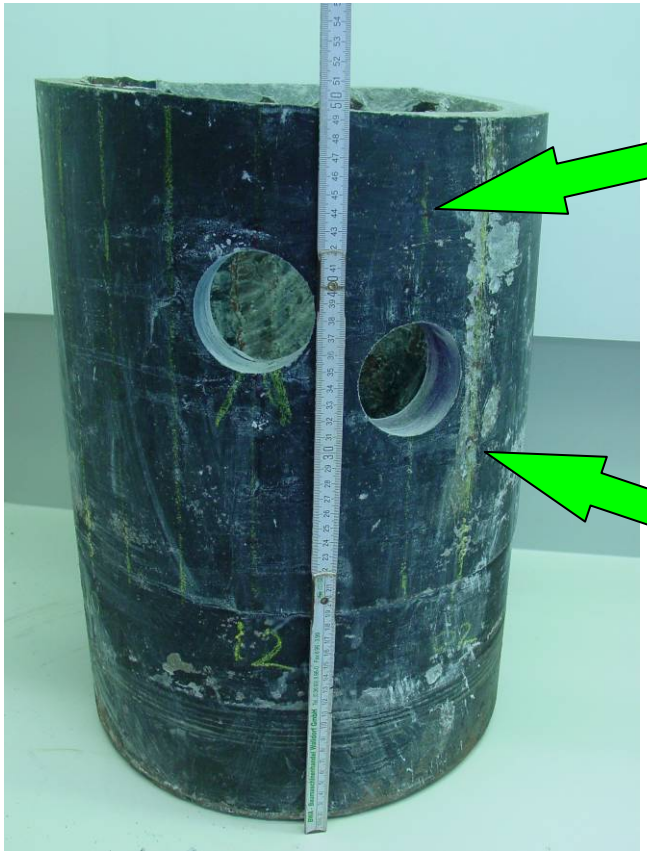
Georadar (Asbestos Cement)



[DWA-M 149-4]

Technology – Phase 2: Slofec/Georadar



Sample 1

Sample 2

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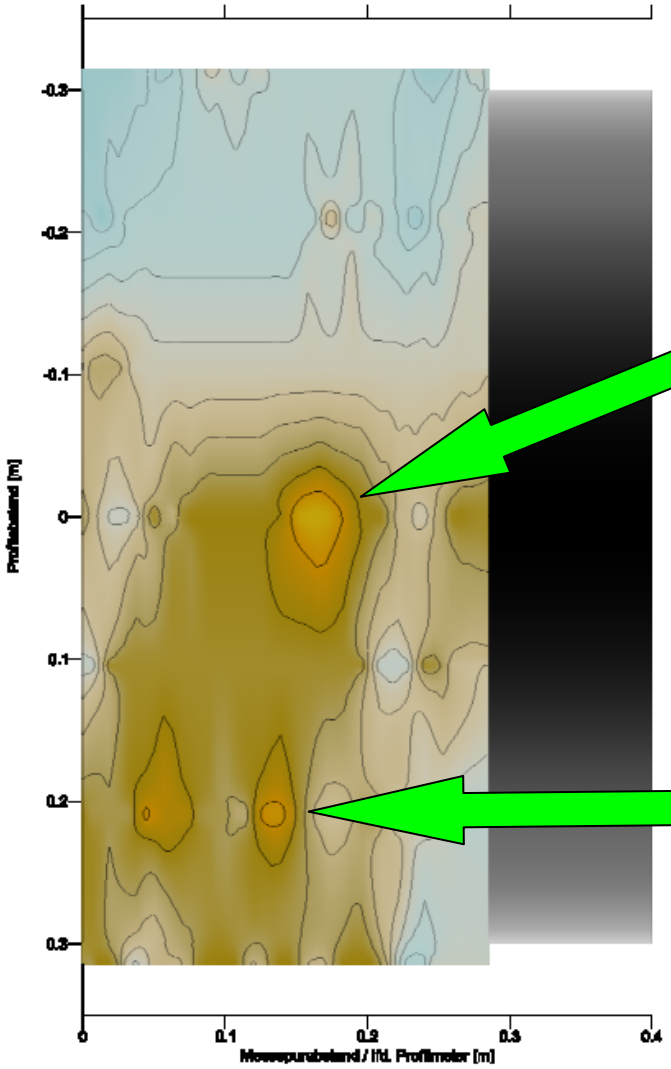
Technology – Phase 2: Slofec/Georadar



Sample 1

Sample 2

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Conclusion

- Both techniques are limited to pipe sizes; What about private pipes (small)?

-The use of these techniques requires a trained individual

- The inspected Pipelines must be not operational

1: Survey - Orientation

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Technology – Phase 3: Pressure Test

Phases of the test

(DIN EN805; DVGW W400-2 …)

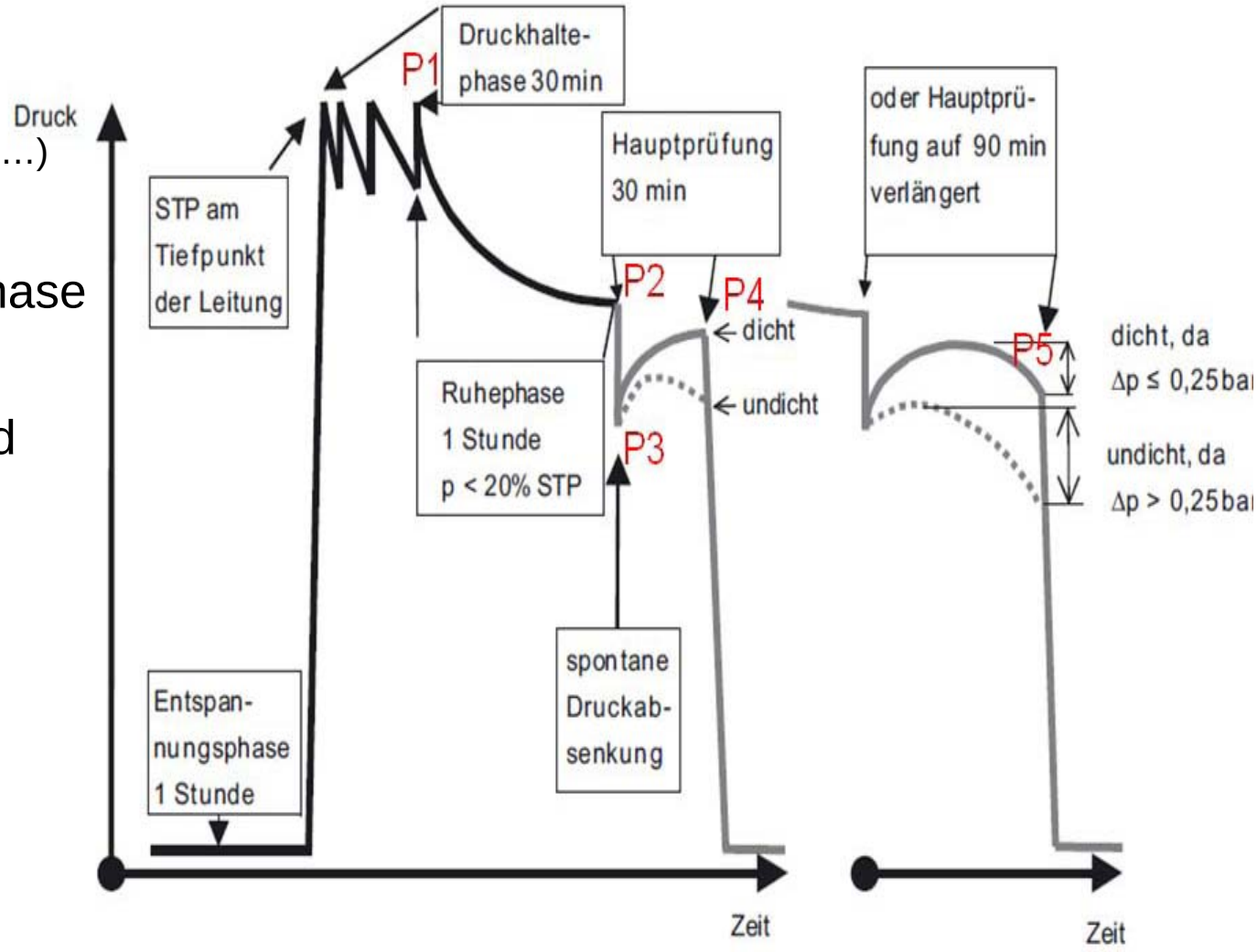
P1: 30 min- holding phase

P2: 60 min Rest period

P3: Pressure drop

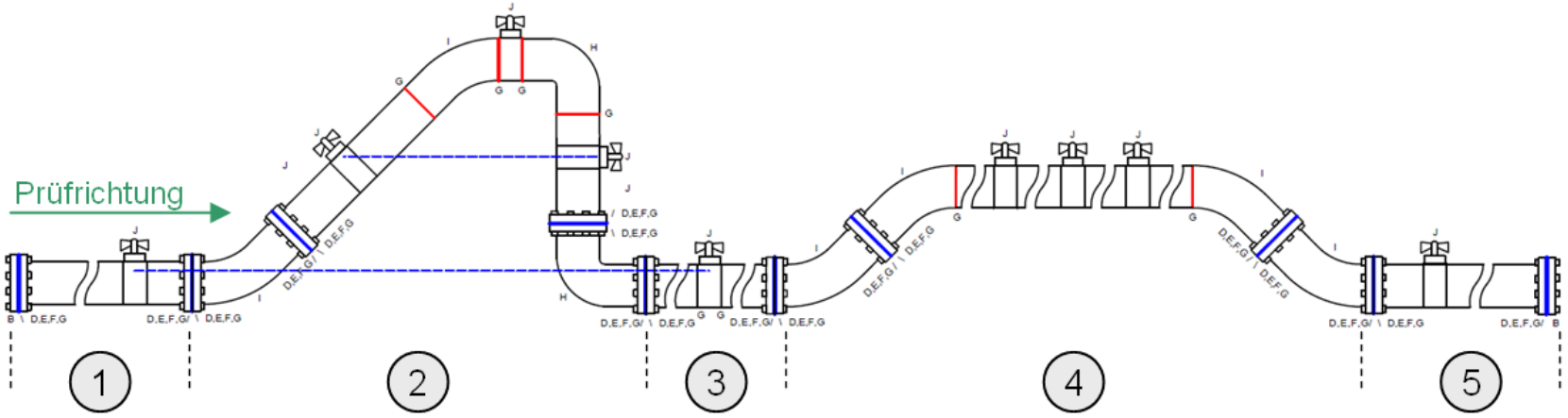
P4: 30 min- main test

P5: 60 min main test



$$dv_{max} = 1{,}2.v.dP.\left[\frac{1}{Ew} + \frac{d}{e}.\frac{1}{Er}\right].l$$

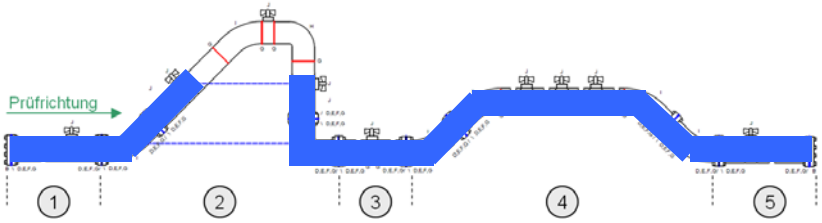
Technology – Phase 3: Pressure Test



- Length ca. 27,0 m
- PE 100 SDR 17, DN 150
- Height difference between HP und LP : h = 80cm
- Multiple venting options

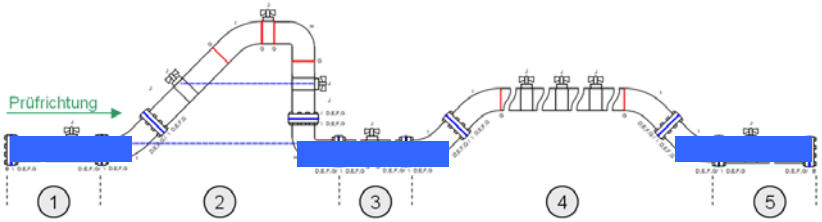
Technology – Phase 3: Pressure Test

Specifying test program / p = 8,0 bar



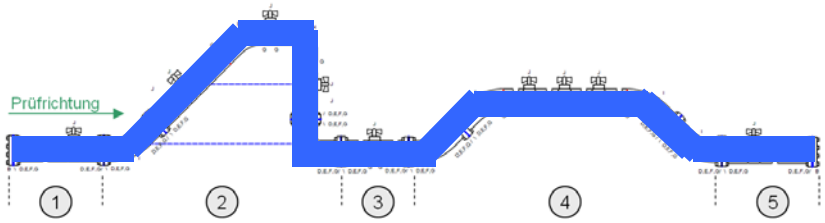
Condition 1

Bow section2 half-filled with air



Condition 2

Bows 2 and 4 filled with air



Condition 3

Pipe completely filled with water

Test results Carried out by IKT

- Pressure Test : 8 to 4 bar
- Leakage : 0,05mm and 0,1mm

Tests	Preliminary Test				Pressure Drop Test	Main Test	
	Relaxation	Pressure build-up	Keep pressure	Resting phase			
Condition 1 (8bar)	✓	✓	✓	✓	X	-	Cancel- leaks not detected
Condition 2 (8bar)	✓	✓	✓	✓	X	-	Cancel - Leaks not detected
Condition 3 (8bar)	✓	✓	✓	✓	✓	✓	passed, Given leaks
Condition 3 (4bar)	✓	✓	✓	✓	✓	✓	passed, Given leaks

Test results Carried out by private companies

		Vorprüfung					Hauptprüfung		
	Prüfung	Ent-spannung	Druck-aufbau	Druck halten	Ruhe-phase	Druck-abfall-prüfung	normal	verlängert	
DL A	Zustand 1 (8 bar)	✓	✓	✓	✓	✗	✓	-	**nicht bestanden** nach Norm
	Zustand 2 (8 bar)	✓	✓	✓	✓	✗	✓	-	**nicht bestanden** nach Norm
DL B	Zustand 1 (8 bar)	✓	✓	✓	✓	✗	✓	-	**nicht bestanden** nach Norm
	Zustand 3 (8 bar)	✓	✓	✓	✓	✓	✓	-	**Bestanden**, Dichtheit gegeben
DL C	Zustand 1 (8 bar)	✓	✓	✓	✓	✓	✗	✗	**nicht bestanden**
	Zustand 3 (8 bar / verkürzt)	✓	✓	✓	✓	✓	✓	-	**Bestanden**, Dichtheit gegeben
	Zustand 3 (8 bar)	✓	✓	✓	✓	✓	✓	-	**Bestanden**, Dichtheit gegeben
	Zustand 3 (4 bar)	✓	✓	✓	✓	✓	✓	-	**Bestanden**, Dichtheit gegeben
	Zustand 1 (4 bar)	✓	✓	✓	✓	✗	-	-	**Abbruch**, Dichtheit nicht feststellbar
	Zustand 1 (4 bar / verkürzt)	✓	✓	✓	✓	✗	-	-	**Abbruch**, Dichtheit nicht feststellbar
DL D	Zustand 1 (8 bar)	✓	✓	✓	✓	✗	✓	-	**nicht bestanden** nach Norm
	Zustand 3 (8 bar)	✓	✓	✓	✓	✓	✓	-	**Bestanden**, Dichtheit gegeben

Conclusion

- The pressure test (Leaks) according to DIN EN 805 standard requires a high-performance hardware and reliable knowledge
- Private operators are far from meeting these requirement

For this purpose, special knowledge in the following areas will be acquired :

- Material Science / Construction Materials
- Hydraulic
- Regulations
- Measurement
- Security

Presentation plan

1: Survey - Orientation

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Conclusion and outlook

- Importance of Sewer pressure pipes
- Material and size
- Optimal diagnostic technique
- Means and knowledge
- Development of a Risk Model
- Market Research for Rehabilitation Techniques for Pressure Pipes
- Implementation of Risk Model at Network Operators