

Reprint bi UmweltBau



Tightness testing of a DN 1500 tube liner

IKT-LinerReport 2010

Tube liner water-tightness constantly improving

All in all, 2010 test results at a high level.
Water-tightness again better, statics characteristics still good.
Only the wall thickness results are poorer than last year.

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This seventh IKT - Institute for Underground Infrastructure LinerReport is based on just on 1,300 tube liner samples taken at construction sites during 2010 and tested at the IKT Tube Liner Test Center.

Data-base

The results presented here are those achieved by installation contractors from whom IKT has tested not less than twenty-five liner samples from five different sites. Eighteen contractors fulfill this requirement, three more than last year. Two installation contractors work only in

the Netherlands, and are indicated by „(NL)“ in the tables.

In 81% of cases, the clients (or their engineering consultancies) commissioned IKT directly for laboratory testing of liner samples, which were, as noted, taken on site. 19% of the assignments were commissioned by the installation contractors themselves (see Table 1).

Table 1: Installation contractors and liner systems

Installation contractor	Liner systems	Liner type	Number of samples	IKT test commissioned by	
				Installation contractor %	Project client %
AKS Umwelttechnik GmbH	Saertex-Liner	GRP	61	0	100
ARKIL INPIPE GmbH	Berolina Liner	GRP	45	0	100
Diringer & Scheidel Rohrsanierung GmbH	RS CityLiner	NF	28	7	93
Diringer & Scheidel Rohrsanierung GmbH	Saertex Liner	GRP	38	26	74
Erles Umweltservice GmbH	Impreg Liner	GRP	119	14	86
Insituform Rohrsanierungstechniken GmbH	Impreg Liner	GRP	113	0	100
Insituform Rohrsanierungstechniken GmbH	Insituform tube liner	NF	66	0	100
Insituform Rioolrenovatietechnieken bv (NL)	Insituform tube liner (NL) Netherlands	NF	44	0	100
Jeschke Umwelttechnik GmbH	Alphaliner	GRP	40	0	100
Karl Weiss GmbH & Co. KG	Brandenburger tube liner	GRP	54	13	87
Kilian Kanalsanierung GmbH	Brandenburger tube liner	GRP	39	0	100
Kleen + Huneke Umwelt & Kanaltechnik GmbH	Saertex Liner	GRP	76	14	86
KMG Pipe Technologies GmbH	Saertex Liner	GRP	40	7	93
KTF Kanaltechnik Friess GmbH	Impreg Liner	GRP	26	42	58
Nelis Infra Aarsleff JV (NL)	PAA-S Liner	NF	51	0	100
Rainer Kiel Kanalsanierung GmbH	Saertex Liner	GRP	110	64	36
Rohr Fuchs Rohrreinigungs GmbH	Impreg Liner	GRP	61	0	100
Swietelsky-Faber GmbH Kanalsanierung	Berolina Liner	GRP	107	10	90
TKT Jens und Lutz Meißner GbR	Alphaliner	GRP	78	53	47
U&W Umwelttechnik u. Wasserbau GmbH	Brandenburger tube liner	GRP	75	79	21
Total			1.271	19	81
GRP: Glass-fiber support material					
NF: Needle-felt support material					

Target/Actual analysis

The characteristics of modulus of elasticity, flexural strength, wall thickness and water-tightness of the tube-liner samples taken from construction sites are analyzed. The Actual data are compared against the Target data from the DIBt approvals and/or with any divergent Target data specified by the client. The Target data for wall thickness are defined on the basis of static calculations or by the client. Tube-liner samples from the Netherlands are evaluated only on the basis of the Target data specified by the client, generally represented by an engineering consultancy.

Two procedures are used in analysis of the water-tightness of needle-felt liners: testing with and without cutting of the inner film. The latter procedure is applied in the case of liners, the DIBt approval for which confirms that the inner film is an integral and tightness-influencing (i.e., sealing) element. On all other needle-felt liners, the inner film is cut. The clients for a number of samples from the Netherlands requested application of both test methods, i.e., both with and without cutting of the inner film. In these cases, both results are stated.

GRP liners are always tested without cutting, since they do not have an inner film which remains in the conduit.

Overview of test and inspection criteria

Modulus of elasticity (short-term flexural modulus)

- Tube liners must be capable of withstanding loads such as those arising from groundwater, road traffic and soil pressure
- The modulus of elasticity is an indicator of load-bearing capability
- Stability may be endangered if modulus of elasticity is too low
- Test method: Three-point bending test as per DIN EN ISO 178 and DIN EN 13 566, Part 4
→Results: see Table 2

Flexural strength

- (bending stress at rupture = short-term σ_{fb})
- This indicates the point at which the liner fails due to excessively high stress
 - If flexural strength is too low, the liner may rupture before the permissible deformation is reached
 - Test method: Increase of load up to failure in the three-point bending test; as per DIN EN ISO 178 and DIN EN 13 566, Part 4 (short-term flexural strength)
→Results: see Table 3

Wall thickness (mean combined thickness)

- Minimum value is specified in the stress-analysis calculation
- Wall thickness and modulus of elasticity jointly determine the stiffness of the liners
- Excessively low wall thickness can endanger stability
- Test method: Mean combined thickness is measured in accordance with DIN EN 13 566, Part 4, using a precision slide gauge
→Results: see Table 4

Water tightness

- A cut is made into the inner film if the latter is not an integral component of the liners; the outer film (if any) is removed
- Water containing a red dye is applied internally
- A 0.5 bar partial vacuum is applied externally
- The liner is „Not tight“ if water penetrates through
- Test period: 30 min.
→Results: see Table 5

Table 2: Test results for modulus of elasticity (Short-term flexural modulus)

Installation contractor	2010		2009	Trend
	No. of samples	Target* achieved in % of tests	Target* achieved in % of tests	
ARKIL INPIPE GmbH	45	100.0	97.1	↑
Erles Umweltservice GmbH	119	100.0	100.0	↔
Insituform Rohrsanierungstechniken GmbH with Impreg-Liner	113	100.0	–	–
Jeschke Umwelttechnik GmbH	40	100.0	100.0	↔**
Karl Weiss GmbH & Co. KG	54	100.0	100.0	↔
Kilian Kanalsanierung GmbH	39	100.0	–	–
KTF Kanaltechnik Friess GmbH	26	100.0	–	–
TKT Jens und Lutz Meißner GbR	78	100.0	97.9	↑**
Rainer Kiel Kanalsanierung GmbH	110	99.1	97.4	↑
Kleen + Huneke Umwelt & Kanaltechnik GmbH	76	98.7	96.2	↑
U&W Umwelttechnik u. Wasserbau GmbH	75	98.7	100.0	↓
Rohr Fuchs Rohrreinigung GmbH	61	98.4	–	–
Swietelsky-Faber GmbH Kanalsanierung	107	98.1	100.0	↓
Insituform Rohrsanierungstechniken GmbH with Insituform tube liner	66	97.0	80.5	↑
Average		96.8	96.4	↑
Diringer & Scheidel Rohrsanierung GmbH with Saertex-Liner	38	94.7	98.2	↓
AKS Umwelttechnik GmbH	61	91.8	–	–
KMG Pipe Technologies GmbH	40	90.0	–	–
Diringer & Scheidel Rohrsanierung GmbH with RS CityLiner	28	89.3	60.0	↑
Nelis Infra Aarsleff JV (NL)	51	80.4	–	–
Insituform Rioolrenovatietechnieken bv (NL)	38	76.3	–	–

* Target data in accordance with client's information (stress analysis/sample traveler card)
** Different liner system used in 2010 than in 2009
– Not evaluated, insufficient liner samples

Table 3: Test results for flexural strength (Short-term σ_{fb})

Installation contractor	2010		2009	Trend
	No. of samples	Target* achieved in % of tests	Target* achieved in % of tests	
AKS Umwelttechnik GmbH	61	100.0	–	–
ARKIL INPIPE GmbH	45	100.0	94.1	↑
Diringer & Scheidel Rohrsanierung GmbH with Saertex-Liner	38	100.0	100.0	↔
Erles Umweltservice GmbH	119	100.0	98.0	↑
Insituform Rohrsanierungstechniken GmbH with Impreg-Liner	113	100.0	–	–
Jeschke Umwelttechnik GmbH	40	100.0	100.0	↔**
Kilian Kanalsanierung GmbH	39	100.0	–	–
Kleen + Huneke Umwelt & Kanaltechnik GmbH	76	100.0	100.0	↔
Rainer Kiel Kanalsanierung GmbH	110	100.0	94.7	↑
U&W Umwelttechnik u. Wasserbau GmbH	75	100.0	100.0	↔
Insituform Rohrsanierungstechniken GmbH with Insituform tube liner	66	98.5	79.6	↑
Rohr Fuchs Rohrreinigung GmbH	61	98.4	–	–
Swietelsky-Faber GmbH Kanalsanierung	107	98.1	100.0	↓
KMG Pipe Technologies GmbH	40	97.5	–	–
TKT Jens und Lutz Meißner GbR	78	97.4	95.8	↑**
Diringer & Scheidel Rohrsanierung GmbH with RS CityLiner	28	96.4	96.0	↑
Karl Weiss GmbH & Co. KG	54	96.3	100.0	↓
KTF Kanaltechnik Friess GmbH	26	96.2	–	–
Average		96.0	96.3	↓
Nelis Infra Aarsleff JV (NL)	51	56.9	–	–
Insituform Rioolrenovatietechnieken bv (NL)	38	52.6	–	–

* Target data in accordance with client's information (stress analysis/sample traveler card)
** Different liner system used in 2010 than in 2009
– Not evaluated, insufficient liner samples

Table 4: Test results for wall thickness (mean combined thickness in accordance with DIN EN 13 566, Part 4)

Installation contractor	2010		2009	Trend
	No. of samples	Target* achieved in % of tests	Target* achieved in % of tests	
Diringer & Scheidel Rohrspanierung GmbH with RS CityLiner	28	100.0	96.0	↑
Diringer & Scheidel Rohrspanierung GmbH with Saertex-Liner	27	100.0	87.6	↑
Jeschke Umwelttechnik GmbH	35	100.0	100.0	↔**
KTF Kanaltechnik Friess GmbH	26	100.0	–	–
Kleen + Huneke Umwelt & Kanaltechnik GmbH	75	98.7	100.0	↓
Rohr Fuchs Rohrreinigung GmbH	61	98.4	–	–
Erles Umweltservice GmbH	117	98.3	91.8	↑
TKT Jens und Lutz Meißner GbR	55	98.2	90.7	↑**
Nelis Infra Aarsleff JV (NL)	39	97.4	–	–
Rainer Kiel Kanalsanierung GmbH	89	96.6	86.8	↑
Kilian Kanalsanierung GmbH	39	94.9	–	–
Insituform Rioolrenovatietechnieken bv (NL)	44	93.2	–	–
Average		89.1	91.9	↓
Insituform Rohrspanierungstechniken GmbH with Impreg-Liner	51	88.2	–	–
U&W Umwelttechnik u. Wasserbau GmbH	75	88.0	94.1	↓
KMG Pipe Technologies GmbH	33	87.9	–	–
AKS Umwelttechnik GmbH	57	86.0	–	–
Insituform Rohrspanierungstechniken GmbH with Insituform tube liner	50	80.0	98.9	↓
ARKIL INPIPE GmbH	36	77.8	97.4	↓
Karl Weiss GmbH & Co. KG	51	70.6	68.8	↑
Swietelsky-Faber GmbH Kanalsanierung	93	52.7	89.1	↓

* Target data in accordance with client's information (stress analysis/sample traveler card)
 ** Different liner system used in 2010 than in 2009
 – Not evaluated, insufficient liner samples

Three-point bending test on a DN 1500 tube liner



Table 5a: Test results for water tightness

Installation contractor	2010		2009	Tendenz
	No. of samples	Watertight in % of tests	Watertight in % of tests	
AKS Umwelttechnik GmbH	61	100.0	–	–
Diringer & Scheidel Rohrsanierung GmbH with Saertex-Liner	38	100.0	93.6	↑
Erles Umweltservice GmbH	114	100.0	98.0	↑
Insituform Rohrsanierungstechniken GmbH, with Insituform tube liner	not cut*	63	100.0	↑
	cut*	3	100.0	↑
Jeschke Umwelttechnik GmbH	40	100.0	100.0	↔**
Kilian Kanalsanierung GmbH	39	100.0	–	–
Kleen + Huneke GmbH	76	100.0	100.0	↔
KMG Pipe Technologies GmbH	40	100.0	–	–
KTF Kanaltechnik Friess GmbH	26	100.0	–	–
Rainer Kiel Kanalsanierung GmbH	109	100.0	100.0	↔
Rohr Fuchs Rohrreinigung GmbH	61	100.0	–	–
TKT Jens und Lutz Meißner GbR	78	100.0	95.8	↑**
U&W Umwelttechnik u. Wasserbau GmbH	36	100.0	97.3	↑
Average		98.4	96.8	↑
Karl Weiss GmbH & Co. KG	54	98.1	96.9	↑
Swietelsky-Faber GmbH Kanalsanierung	104	98.1	98.0	↑
Arkil Inpipe GmbH	45	97.8	94.9	↑
Insituform Rohrsanierungstechniken GmbH with Impreg-Liner	113	95.6	–	–
Diringer & Scheidel Rohrsanierung GmbH with RS CityLiner	28	67.9	76.0	↓
* With/without cutting of the integrated inner film (at client's request)				
** Different liner system used in 2010 than in 2009				
– Not evaluated, insufficient liner samples				

Table 5b: Test results for water-tightness (Netherlands)

Installation contractor	2010		2009	Trend
	No. of samples	Watertight in % of tests	Watertight in % of tests	
Nelis Infra Aarsleff JV (NL), (film not cut)	31	96.8	–	–
Insituform Rioolrenovatietechnieken bv (NL), (film not cut)	15	93.3	–	–
Average		62.0		
Insituform Rioolrenovatietechnieken bv (NL), (film cut)	25	36.0	–	–
Nelis Infra Aarsleff JV (NL), (film cut)	29	31.0	–	–
- Not evaluated, insufficient liner samples				

Modulus of elasticity and flexural strength maintain last year's level

The average results for modulus of elasticity continue to maintain an extremely high level, at 96.8 % of tests successfully passed, a small increase, of +0.4 percent points (%P). GRP liners have fallen back extremely slightly, by -0.6 %P, compared to the previous standard, while needle-felt liners (NF) have improved significantly, by +10.1 %P.

The average number of tests successfully passed in the case of flexural strength remains virtually unchanged (-0.3 %P) vis-à-vis the previous year. GRP liners improved by +1.0 %P, while NF liners deteriorated by -5.6 %P. Only two installation contractors from

the Netherlands remain below the overall average.

Wall thickness poorer

Of the four test criteria, wall thickness developed least pleasingly. The average of tests passed fell back noticeably, at -2.8 %P. As in the past, GRP liners achieve poorer results in this test than NF liners. This was also confirmed in 2010. NF liners lost more ground (-7.0 %P) than GRP liners (-2.5 %P) in comparison with the previous year.

Water-tightness improved

The results for water-tightness improved to a highly respectable 98.4 %, a renewed rise by

an average of +1.6 %P. GRP liners pass 99.1 % of the tests (+1.8 %P) on average, and NF liners still a respectable 90.4 % (-2.7 %P). Worth of note is the fact that fourteen of nineteen results for this year (Table 5a) achieve a tightness rate of 100 %, i.e., not a single site sample failed to be tight. The remaining results - with one exception - are all only slightly below the average.

The test results for water-tightness achieved by the Dutch liners are, on average, significantly below those of the German samples. They are stated separately for this test criterion, since the German standards for water-tightness are applied for evaluation only in some cases in the Netherlands.

Table 6: Test results classified by liner types

Liner system	Water-tightness		Modulus of elasticity		Flexural strength		Wall thickness	
	No. of samples	Watertight in % of tests	No. of samples	Target* achieved in % of tests	No. of samples	Target* achieved in % of tests	No. of samples	Target* achieved in % of tests
Alphaliner	118	100.0	118	100.0	118	98.3	90	98.9
Impreg-Liner	314	98.4	319	99.7	319	99.4	255	96.5
Brandenburger tube liner	129	99.2	168	99.4	168	98.8	165	84.2
Insituform tube liner	not cut	63	100.0	66	66	98.5	50	80.0
	cut	3	100.0					
Saertex-Liner	324	100.0	325	96.0	325	99.7	281	94.3
Berolina Liner	149	98.0	152	98.7	152	98.7	129	59.7
RS CityLiner	28	67.9	28	89.3	28	96.4	28	100.0
PAA-S-Liner (NL)	not cut	31	96.8	51	51	56.9	39	97.4
	cut	29	31.0					
Insituform tube liner (NL)	not cut	15	93.3	38	38	52.6	44	93.2
	cut	25	36.0					
Average		98,4**		96.8		96.0		89.1

■ above average
■ below average
 * Target data in accordance with client's information (stress analysis/sample traveler card)
 ** Average excluding samples from the Netherlands

Table 7: Test results compared to results for previous year

Liner type	Watertight in % of tests			Modulus of elasticity target* achieved in % of tests			Flexural strength target* achieved in % of tests			Wall thickness target* achieved in % of tests		
	2010	2009	+/-	2010	2009	+/-	2010	2009	+/-	2010	2009	+/-
Averages												
- All samples	98.4**	96.8	+1.6 ↑	96.8	96.4	+0.4 ↑	96.0	96.3	-0.3 ↓	89.1	91.9	-2.8 ↓
- GRP	99.1	97.3	+1.8 ↑	98.4	99.0	-0.6 ↓	99.2	98.2	+1.0 ↑	88.7	91.2	-2.5 ↓
- NF	90.4**	93.1	-2.7 ↓	86.9	76.8	+10.1 ↑	77.0	82.6	-5.6 ↓	91.3	98.3	-7.0 ↓

GRP: Glass-fiber support material
 NF: Needle-felt support material
 * Target data in accordance with client's information (stress analysis/sample traveler card)
 ** Average excluding samples from the Netherlands

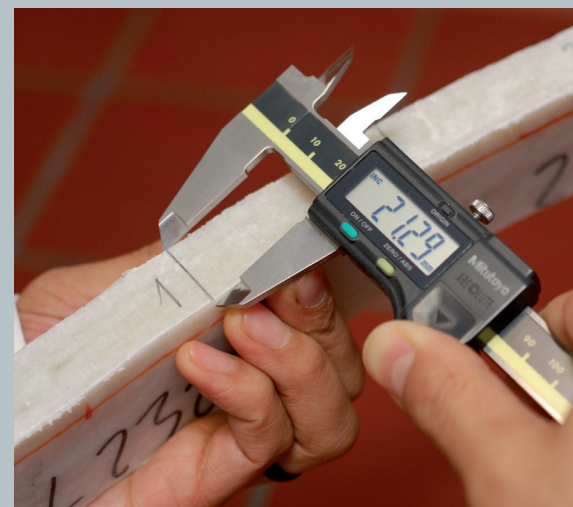
Conclusion

The 2010 IKT LinerReport documents a continuing high quality level for repair using tube liners. The average results for modulus of elasticity and flexural strength remain virtually identical to those for the previous year, whereas wall thickness produces poorer test results this year.

Water-tightness - the test criterion to which the technical world attaches great importance - has again improved, on the other hand, even compared to the already high level set by the previous year's results. The fact that this is not a matter of course is shown by the test results achieved by the Dutch installation contractors.

A positive trend, on the whole, when the average values are examined. It is, however, unmistakable that there are, in some cases, significant downward deviations from the averages. Clients would therefore be well advised in future to formulate their quality requirements as early as the invitation-to-tender stage, and to monitor adherence to these requirements by means of tests and inspections.

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Liner wall-thickness is measured using a precision slide caliper gauge