Ten years of the IKT LinerReport

Quality and transparency oblige

Three-point bending test on a tube liner

The IKT test centre has been publishing annual reports on the results of its tube liner tests since 2004. Are tube liners better today? What trends are apparent? And what is the current picture?

There is cause for a small celebration: the IKT now presents its LinerReport, an annual overview of tube liner quality, for the tenth time in succession. An excellent occasion, therefore, to chance a look back at the statistics, and assess the developments in the quality of the most important refurbishing method.

The aim: market transparency via publicity

Not everyone will be reaching straight for the champagne, however - this year's IKT LinerReport, as always, touches on one or two sore points, setting off agitated discussions among the expert public that has not always remained unclouded by emotion. The focus, from the very start, was the extent to which a number of pivotal quality criteria promised by tube liner suppliers to customers, and specified for their products in the DIBt (German Institute for Building Technology) approvals, are actually met in on-site practice. The IKT's aim with its LinerReport has always been, and remains, to achieve transparency and publicity, in order thus to prompt tube-liner quality improvements.

The tightness debate

Even after the very first IKT LinerReport in 2004, a heated debate flared up concerning whether tube liners really need to be 100 percent tight. A number of liner producers and users pointed out that the test standards permitted water losses during tightness testing, even in the case of new pipes, drawing from this the conclusion that a tube liner should not be assessed more strictly than a newly installed concrete pipe.

Municipal system operators, above all, drew attention, conversely, to the legal requirement that waste-water conduits must be tight, in order to protect the environment, arguing that the test specifications for concrete pipes could not automatically be applied to tube liners produced from ultra-modern plastics, due to the totally different material properties, and that only additions of water, and under no circumstances water losses, are actually tolerated. The debate ended with a victory for the clients' view that tube liners must be tight.

One particular marginal note was the controversy concerning cutting of the inner film prior to the water-tightness test (see „Overview of test and inspection criteria"). Some producers argued in their own defence that such cutting would damage the liner laminate and thus actually be the cause of leakage. They were unable to produce any evidence for this, however.

Diagram 1: Number of liner samples
IKT-LinerReport 2003 - 2013

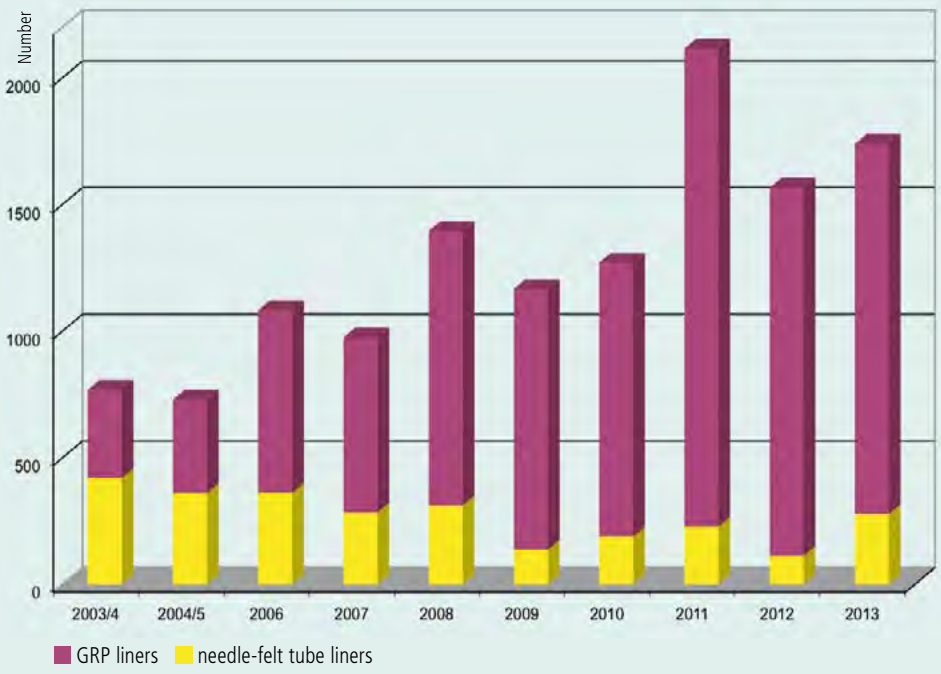


Diagram 2: Test results of all samples
Average „Target value achieved"

Diagram 3: Test results GRP liners
Average „Target value achieved"

Diagram 4: Test results needle-felt tube liners
Average „Target value achieved"

- – – Modulus of elasticity
- ——— Flexural strength
- - - - - - Wall thickness
- —·— Water-tightness

This controversy, which was scarcely comprehensible even for expert insiders, ultimately concluded with a number of producers of needle-felt tube liners applying for amendment of their DIBt approvals. The inner film has since this time been defined as an integral part of the liner and is no longer cut prior to the test. It was, however, necessary to demonstrate in advance the suitability of these films by means of a DIBt test programme. The results of the water-tightness test then improved significantly (from 2009 onward, see Diagram 4).

Wall thickness a weak point

The IKT LinerReport also disclosed a number of weak points in the mechanical properties of the tube liners. It became apparent, for example, that the specified load-bearing capacities and the wall thicknesses necessary on a structural-analysis basis were not achieved on every site. This, again, set off a heated debate on test and measuring procedures, with confrontation between those advocating a less stringent interpretation of clients' specifications and those in favour of higher quality standards. The latter pointed out that a minimum service-life of fifty years is promised to them, as customers, for their tube liners. The specified materials characteristics data, they asserted, must therefore be assured at least at the time of installation.

Binding quality criteria for all

As objections from the ranks of the municipalities became ever more vociferous, and a number of them actually discontinued the use of tube liners, the tube-liner manufacturers and municipal representatives ultimately formed a workgroup which defined binding quality criteria for tube liners, up to and including sanction mechanisms to be applied in case of non-compliance. This workgroup was assisted by engineering consultancies and test institutions.

The test procedures for tube liners were also defined by mutual agreement within a similar framework. The original dispute concerning liner tightness was decided unequivocally in favour of the tight liner. In a final step, these papers were incorporated into DWA (German Association for Water, Wastewater and Waste) codes A 143, Part 3 and M 144, Part 3 in 2012.

Retrospective 2003 – 2013

The ten previous IKT LinerReports incorporated the test results of a total of just on 13,000 site samples. Of these, 10,000 were taken from GRP liners, and slightly less than 3,000 from needle-felt (NF) liners. The numerical balance between GRP and NF liners had been virtually equal in the first two LinerReports, but the picture changed clearly, in favour of GRP liners, from 2006 onward at the latest (see Diagram 1), reflecting the now greater market importance of this composite material. New suppliers have entered the market in recent years, NF suppliers have added GRP to their ranges, and traditional GRP suppliers have improved their products and launched new versions.

10 percent plus in 10 years

The overall picture for the past ten years shows a significant improvement in the test results for modulus of elasticity, flexural tensile strength, wall thickness and water tightness. As late as 2008, the data still fluctuated between an average of 85 percent and 95 percent of tests passed which, conversely, means that there were, on average, problems with tube liners immediately after installation in an average of 15 percent of all cases. The results consistently exceeded the 95 percent boundary on average only from 2009 onward, and are currently tending toward the 98 percent mark. Only in the case of the „wall thickness" criterion are the targets achieved less frequently.

All in all, tube-liner quality manifests a clear upward trend. The results for all four criteria have improved by an average of 10 percentage points in the last ten years.

Assessment of GRP vs. needle-felt liners

It is readily apparent, when one examines the test results for GRP and NF liners (see Diagrams 3 and 4) that GRP liners achieve scores of above 95 percent on average almost continuously for the criteria of modulus of elasticity, flexural tensile strength and water tightness (exception: 2006). The results for wall thickness lag significantly behind, however, catching up with the good results for the other three criteria only in 2013. Whether this will be a permanent improvement remains to be seen.

Except in the case of wall thickness, the average test results for the NF liners are generally significantly below those for the GRP liners, on the other hand (see Diagram 4). They also fluctuate significantly from year to year. They consistently cross the 95 percent mark only from 2011 on, catching up with the GRP liners although, with the exception of water tightness, they drop back again slightly in 2013.

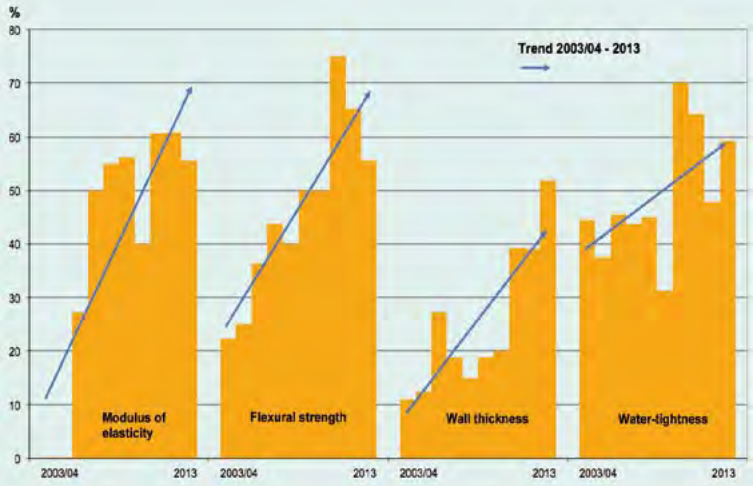
The data-base for 2013

The IKT LinerReport 2013 includes the results for those refurbishing contractors for whom the IKT tested not less than twenty-five liner samples of one liner type from five different sites. This condition is fulfilled by twenty contractors. Of these, five are represented by more than one liner type. Three contractors worked only in the Netherlands, while two worked in Switzerland. For the first time, the list also includes a company from Austria. These companies are indicated by (NL), (CH) and (A) in the tables.

In 73 percent of cases, the project clients (or their engineering consultancies) commissioned the IKT directly for laboratory testing of liner samples. 27 percent of orders originated from the refurbishing contractors themselves (see Table 1).

Diagram 5: Refurbishing contractors with 100% success rates

Number of contractors in percent per test criterion



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 ISO 11296, Part 4/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; in accordance with DIN EN ISO 178 and DIN EN ISO 11296, Part 4/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 ISO 11296, 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

* DIN EN ISO 11296, Part 4 superseded DIN EN 13566, Part 4 with effect from July 2011. The test results are nonetheless evaluated on the basis of DIN EN 13566, Part 4 for a number of liner systems, since the Target data for the mechanical properties (national technical approvals) were determined in accordance with this standard.

** Determination of combined thickness remains unchanged in DIN EN ISO 11296, Part 4 vis-à-vis DIN EN 13566, Part 4.

Table 1: Refurbishing contractors and liner systems 2013

Refurbishing contractors	Liner systems	Liner type	Number of samples	IKT test commissioned by	
				Refurbishing contractor %	Project client %
Aarsleff Rohrsanierung GmbH	Impreg liner	GRP	60	12	88
Aarsleff Rohrsanierung GmbH	PAA GF liner**	GRP	66	3	97
Aarsleff Rohrsanierung GmbH	PAA SF liner**	NF	158	2	98
Arkil Inpipe GmbH	Berolina liner	GRP	82	28	72
Arpe AG (CH)	Alphaliner	GRP	31	45	55
Diringer & Scheidel Rohrsanierung GmbH & Co. KG	Alphaliner	GRP	29	0	100
Diringer & Scheidel Rohrsanierung GmbH & Co. KG	RS CityLiner	NF	39	0	100
Diringer & Scheidel Rohrsanierung GmbH & Co. KG	Saertex liner	GRP	34	53	47
Erles Umweltservice GmbH	Impreg liner	GRP	140	74	26
Geiger Kanaltechnik GmbH & Co. KG	Alphaliner	GRP	47	43	57
Geiger Kanaltechnik GmbH & Co. KG	Berolina liner	GRP	70	3	97
Hamers Leidingtechniek B.V. (NL)	Alphaliner	GRP	59	70	30
Huneke Kanalsanierung GmbH	Saertex liner	GRP	78	0	100
Insituform Rioolrenovatietechnieken bv (NL)	Insituform tube liner (NL)*** Netherlands	NF	82	0	100
ISS Kanal Services AG (CH)	Alphaliner	GRP	27	56	44
Jeschke Umwelttechnik GmbH	Alphaliner	GRP	66	46	54
Jeschke Umwelttechnik GmbH	Brandenburg liner BB+75/120	GRP	37	0	100
Kanaltechnik Agricola GmbH	Impreg liner	GRP	26	42	58
KATEC Kanaltechnik Müller & Wahl GmbH	Alphaliner	GRP	42*	0	100
Max Bögl Bauunternehmung GmbH & Co. KG	Brandenburg liner BB 2.0/2.5	GRP	47*	43	57
Rainer Kiel Kanalsanierung GmbH	Saertex liner	GRP	38	37	63
Strabag AG (A)	Brandenburg liner BB 2.0/2.5	GRP	27	93	7
Swietelsky-Faber GmbH Kanalsanierung	Alphaliner	GRP	49	2	98
Swietelsky-Faber GmbH Kanalsanierung	Berolina liner	GRP	29*	0	100
TKT Jens und Lutz Meißner GbR	Alphaliner	GRP	140	21	79
Umwelttechnik und Wasserbau GmbH	Alphaliner	GRP	195	37	63
Van der Velden Rioleringsbeheer B.V. (NL)	Impreg liner	GRP	42	38	62
Total			**1.740**	**27**	**73**

GRP: Glass-fibre backing material | NF: Needle-felt backing material

* from four sites

** The Danish building contractor Per Aarsleff A/S increased its shareholding in Insituform Rohrsanierungstechniken GmbH to 100 percent in mid-2013 and renamed the company Aarsleff Rohrsanierung GmbH. The products previously known under the Insituform GF-Liner and Insituform tube liner designations were renamed PAA GF liner and PAA SF liner. Test results prior to 8 August 2013 were obtained on site samples for Insituform Rohrsanierungstechnik GmbH, but are listed here under the new Aarsleff Rohrsanierung GmbH designation.

*** no DIBt approval

Target/Actual analysis

The properties of modulus of elasticity, flexural strength, wall thickness and water tightness of the tube-liner samples from the sites were tested. The Actual values are compared against the Target values from the DIBt approvals and/or with any divergent Target specifications by the client. Tube liners with no DIBt approval are indicated in Table 1. The Target values for wall thickness are specified on the basis of structural-analysis calculations, or are specified by the client.

There are two procedures for testing of the water tightness of needle-felt liners: with and without cutting of the inner film. The latter procedure is selected where the DIBt approval for the particular liner confirms that the inner film is an integral element and plays a role in tightness. The inner film is cut on all other needle-felt liners.

GRP liners are tested without cutting unless they have an inner film which remains in the conduit.

Table 2: Test results 2013 for modulus of elasticity (short-term flexural modulus)

Refurbishing contractors	2013		2012	Trend
	Number of samples	Target value* achieved in % of tests	Target value* achieved in % of tests	
Aarsleff Rohrsanierung GmbH with Impreg liner	60	100.0	100.0**	◂▸
Arkil Inpipe GmbH with Berolina liner	82		97.4	▲
Diringer & Scheidel Rohrsanierung GmbH with Alphaliner	29		97.1	▲
Diringer & Scheidel Rohrsanierung GmbH with Saertex liner	34		100.0	◂▸
Erles Umweltservice GmbH	140		100.0	◂▸
Geiger Kanaltechnik GmbH & Co. KG with Berolina liner	70		100.0	◂▸
Hamers Leidingtechniek B.V. (NL)	59		98.1	▲
ISS Kanal Services AG (CH)	27		100.0	◂▸
Jeschke Umwelttechnik GmbH with Alphaliner	66		100.0	◂▸
Jeschke Umwelttechnik GmbH with Brandenburg liner BB+75/120	37		–	–
Kanaltechnik Agricola GmbH	26		100.0	◂▸
Max Bögl Bauunternehmung GmbH & Co. KG	47		–	–
Strabag AG (A)	27		–	–
Swietelsky-Faber GmbH Kanalsanierung with Berolina liner	29		100.0	◂▸
Van der Velden Rioleringsbeheer B.V. (NL)	42		98.4	▲
Umwelttechnik und Wasserbau GmbH	195	99.5	98.4	▲
TKT Jens und Lutz Meißner GbR	140	98.6	100.0	▼
Aarsleff Rohrsanierung GmbH with PAA GF liner	66	98.5	100.0**	▼
Average		**98.3**	**98.7**	▼
Swietelsky-Faber GmbH Kanalsanierung with Alphaliner	49	98.0	–	–
Aarsleff Rohrsanierung GmbH with PAA SF liner	158	97.5	100.0**	▼
Huneke Kanalsanierung GmbH	77	97.4	–	–
Rainer Kiel Kanalsanierung GmbH	38	97.4	98.3	▼
Arpe AG (CH)	31	96.8	–	–
KATEC Kanaltechnik Müller & Wahl GmbH	42	95.2	90.1	▲
Diringer & Scheidel Rohrsanierung GmbH with RS CityLiner	39	94.9	–	–
Insituform Rioolrenovatietechnieken bv (NL)	82	91.5	96.9	▼
Geiger Kanaltechnik GmbH & Co. KG with Alphaliner	45	88.9	–	–

* Target values as per client's data (structural analysis/traveller card) | ** Insituform Rohrsanierungstechniken GmbH in 2012 | – not evaluated, too few liner samples

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

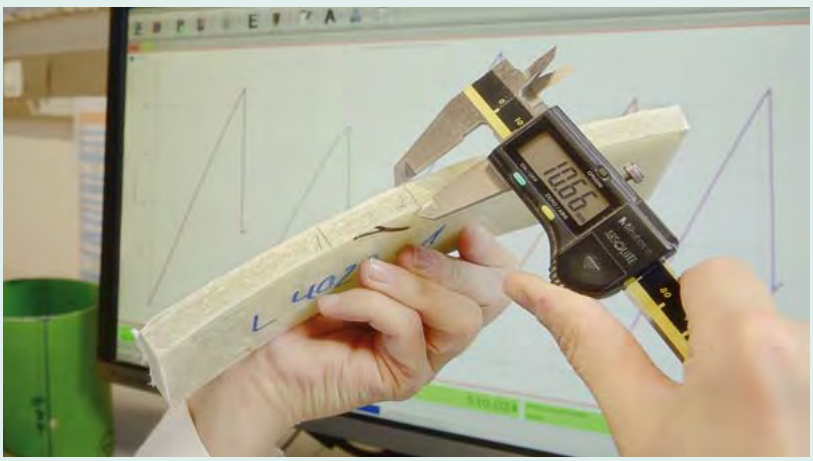
Refurbishing contractors	2013		2012	Trend
	Number of samples	Target value* achieved in % of tests	Target value* achieved in % of tests	
Arkil Inpipe GmbH with Berolina liner	82	100.0	100.0	◂▸
Arpe AG (CH)	31		–	–
Diringer & Scheidel Rohrsanierung GmbH with Alphaliner	29		100.0	◂▸
Diringer & Scheidel Rohrsanierung GmbH with RS CityLiner	39		–	–
Diringer & Scheidel Rohrsanierung GmbH with Saertex Liner	34		100.0	◂▸
Geiger Kanaltechnik GmbH & Co. KG with Berolina liner	70		100.0	◂▸
Hamers Leidingtechniek B.V. (NL)	59		100.0	◂▸
ISS Kanal Services AG (CH)	27		100.0	◂▸
Jeschke Umwelttechnik GmbH with Alphaliner	66		100.0	◂▸
Jeschke Umwelttechnik GmbH with Brandenburg liner BB+75/120	37		–	–
Kanaltechnik Agricola GmbH	26		100.0	◂▸
Rainer Kiel Kanalsanierung GmbH	38		100.0	◂▸
Swietelsky-Faber GmbH Kanalsanierung with Alphaliner	49		–	–
TKT Jens und Lutz Meißner GbR	140		99.4	▲
Van der Velden Rioleringsbeheer B.V. (NL)	42		98.4	▲
Umwelttechnik und Wasserbau GmbH	195	99.5	98.4	▲
Erles Umweltservice GmbH	140	99.3	100.0	▼
Huneke Kanalsanierung GmbH	77	98.7	–	–
Aarsleff Rohrsanierung GmbH with PAA GF liner	66	98.5	100.0**	▼
Average		**98.5**	**98.7**	▼
Aarsleff Rohrsanierung GmbH with Impreg liner	60	98.3	100.0**	▼
Max Bögl Bauunternehmung GmbH & Co. KG	47	97.9	–	–
Geiger Kanaltechnik GmbH & Co. KG with Alphaliner	45	97.8	–	–
KATEC Kanaltechnik Müller & Wahl GmbH	42	97.6	96.4	▲
Aarsleff Rohrsanierung GmbH with PAA SF liner	158	97.5	98.8**	▼
Swietelsky-Faber GmbH Kanalsanierung with Berolina liner	29	96.6	100.0	▼
Strabag AG (A)	27	96.3	–	–
Insituform Rioolrenovatietechnieken bv (NL)	82	85.4	87.5	▼

* Target values as per client's data (structural analysis/traveller card) | ** Insituform Rohrsanierungstechniken GmbH in 2012 | – not evaluated, too few liner samples

Table 4: Test results for wall thickness (average combined thickness in accordance with DIN EN ISO 11296, Part 4)

Refurbishing contractors	2013		2012	Trend
	Number of samples	Target value* achieved in % of tests	Target value* achieved in % of tests	
Aarsleff Rohrsanierung GmbH with PAA GF liner	45	100.0	88.7**	↑
Arpe AG (CH)	11		–	–
Diringer & Scheidel Rohrsanierung GmbH with RS CityLiner	25		–	–
Geiger Kanaltechnik GmbH & Co. KG with Alphaliner	35		–	–
Hamers Leidingtechniek B.V. (NL)	59		100.0	↔
ISS Kanal Services AG (CH)	26		95.2	↑
Jeschke Umwelttechnik GmbH with Alphaliner	57		100.0	↔
Jeschke Umwelttechnik GmbH with Brandenburg liner BB+75/120	37		–	–
Kanaltechnik Agricola GmbH	26		100.0	↔
Max Bögl Bauunternehmung GmbH & Co. KG	47		–	–
Rainer Kiel Kanalsanierung GmbH	14		100.0	↔
Strabag AG (A)	22		–	–
Swietelsky-Faber GmbH Kanalsanierung with Alphaliner	25		–	–
Umwelttechnik und Wasserbau GmbH	144		95.0	↑
Huneke Kanalsanierung GmbH	66	98.5	–	–
KATEC Kanaltechnik Müller & Wahl GmbH	37	97.3	88.2	↑
Van der Velden Rioleringsbeheer B.V. (NL)	34	97.1	80.7	↑
Erles Umweltservice GmbH	132	97.0	97.5	↓
Average		**96.5**	**94.0**	↑
Aarsleff Rohrsanierung GmbH with Impreg liner	25	96.0	100.0**	↓
TKT Jens und Lutz Meißner GbR	73	95.9	100.0	↓
Aarsleff Rohrsanierung GmbH with PAA SF liner	95	95.8	100.0**	↓
Diringer & Scheidel Rohrsanierung GmbH with Saertex Liner	22	95.5	100.0	↓
Geiger Kanaltechnik GmbH & Co. KG with Berolina liner	21	95.2	85.7	↑
Arkil Inpipe GmbH with Berolina Liner	58	91.4	***	–
Diringer & Scheidel Rohrsanierung GmbH with Alphaliner	22	90.9	95.7	↓
Insituform Rioolrenovatietechnieken bv (NL)	82	76.8	87.5	↓
Swietelsky-Faber GmbH Kanalsanierung with Berolina liner	2	***	96.0	–

* Target values as per client's data (structural analysis/traveller card) | ** Insituform Rohrsanierungstechniken GmbH in 2012 | – not evaluated, too few liner samples
*** too few samples with details of Target value for combined thickness



Combined thickness and pure-resin layer are measured using precision slide gauges

Tightness testing of tube liners

Table 5: Test results 2013 for water tightness

Refurbishing contractors	2013		2012	Trend
	Number of samples	Watertight in % of tests	Watertight in % of tests	
Aarsleff Rohrsanierung GmbH mit PAA SF-Liner*	158	100.0	100.0**	◂▸
Arkil Inpipe GmbH mit Berolina Liner	82		92.3	▲
Arpe AG (CH)	29		–	–
Diringer & Scheidel Rohrsanierung GmbH mit Alphaliner	29		97.1	▲
Diringer & Scheidel Rohrsanierung GmbH mit Saertex Liner	34		100	◂▸
Geiger Kanaltechnik GmbH & Co. KG mit Alphaliner	47		–	–
Hamers Leidingtechniek B.V. (NL)	59		100.0	◂▸
Huneke Kanalsanierung GmbH	78		–	–
ISS Kanal Services AG (CH)	27		100.0	◂▸
Jeschke Umwelttechnik GmbH mit Alphaliner	66		100.0	◂▸
Jeschke Umwelttechnik GmbH mit Brandenburger Liner BB+75/120	37		–	–
Kanaltechnik Agricola GmbH	26		100.0	◂▸
Max Bögl Bauunternehmung GmbH & Co. KG	47		–	–
Rainer Kiel Kanalsanierung GmbH	38		90.0	▲
Strabag AG (A)	27		–	–
Swietelsky-Faber GmbH Kanalsanierung mit Berolina Liner	9		96.5	▲
Umwelttechnik und Wasserbau GmbH	195	99.0	98.4	▲
Erles Umweltservice GmbH	139	98.6	99.1	▼
Geiger Kanaltechnik GmbH & Co. KG mit Berolina Liner	70	98.6	98.7	▼
Aarsleff Rohrsanierung GmbH mit PAA GF-Liner	66	98.5	96.2**	▲
Average		**98.5**	**98.1**	▲
Aarsleff Rohrsanierung GmbH mit Impreg Liner	54	98.1	96.8**	▲
Swietelsky-Faber GmbH Kanalsanierung mit Alphaliner	49	98.0	–	–
Diringer & Scheidel Rohrsanierung GmbH mit RS CityLiner	37	97.3	–	–
TKT Jens und Lutz Meißner GbR	140	97.1	100.0	▼
KATEC Kanaltechnik Müller & Wahl GmbH	42	92.9	97.1	▼
Van der Velden Rioleringsbeheer B.V. (NL)	42	92.9	98.4	▼
Insituform Rioolrenovatietechnieken bv (NL)	82	91.5	81.3	▲

* without cutting of the integrated inner film | ** Insituform Rohrsanierungstechniken GmbH in 2012 | – not evaluated, too few liner samples

Table 6: Test results by liner type

Liner system	Water-tightness		Modulus of elasticity		Flexural strength		Wall thickness	
	Number of samples	Watertight in % of tests	Number of samples	Target value* achieved in % of tests	Number of samples	Target value* achieved in % of tests	Number of samples	Target value* achieved in % of tests
Brandenburg liner BB+75/120	37	100.0	37	100.0	37	100.0	37	100.0
PAA GF liner	66	98.5	66	98.5	66	98.5	45	100.0
Alphaliner	683	98.5	683	98.2	683	99.6	489	98.8
Berolina liner	161	99.4	181	100.0	181	99.4	79	92.4
Brandenburg liner BB 2.0/2.5	74	100.0	74	100.0	74	97.3	69	100.0
Impreg liner	261	97.7	268	100.0	268	99.3	217	97.2
Saertex liner	150	100.0	149	98.0	149	99.3	102	98.0
PAA SF liner	158	100.0	158	97.5	158	97.5	95	95.8
RS CityLiner	37	97.3	39	94.9	39	100.0	25	100.0
Insituform tube liner Netherlands	82	91.5	82	91.5	82	85.4	82	76.8
Average		**98.5**		**98.3**		**98.5**		**96.5**

above or equal to average
below average

* Target values as per client's data (structural analysis/traveller card)

Table 7: Test results compared to 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		
	2013	2012	+/–	2013	2012	+/–	2013	2012	+/–	2013	2012	+/–
Average												
of all samples	98.5	98.1	+0.4 ▲	98.3	98.7	-0.4 ▼	98.5	98.7	-0.2 ▼	96.5	94.0	+2.5 ▲
GRP	98.7	98.4	+0.3 ▲	98.9	98.7	+0.2 ▲	99.3	98.9	+0.4 ▲	98.1	94.0	+4.1 ▲
NF	97.1	94.3	+2.8 ▲	95.3	99.1	-3.8 ▼	94.3	95.6	-1.3 ▼	88.6	93.9	-5.3 ▼

GRP: Glass-fibre backing material
NF: Needle-felt backing material
* Target values as per client's data (structural analysis/traveller card)

Test results 2013

The overall average of the test results is, for the third time in succession, at an extremely high level. The mean non-pass rate for modulus of elasticity, flexural strength and water tightness is below 2 percent, that for wall thickness below 4 percent. All in all, the test results for 2013 are predominantly „Good" to „Very good". The poorer NF test results compared to the previous year can be attributed primarily to a supplier from the Netherlands.

Four 100 percent top groups

A top group of refurbishing contractors has now formed for each of the four test criteria. The liner samples from these contractors achieve the Target values for at least one test criterion in 100 percent of cases (see Tables 2 to 5). Assessment of performance across time discloses a clear trend: the four 100 percent top groups have become significantly larger since the publication of the first IKT Liner-Report ten years ago. The number of refurbishing contractors included in the four 100 percent top groups was between 0 percent and 22 percent (mechanical criteria) and 44 percent (water tightness) in 2003/2004, whereas more than half of the contractors were included in these groups in 2013 (see Diagram 5). 70 percent of all contractors were already in the top groups for the criteria of flexural tensile strength and water tightness in 2010 and 2011, however.

The 100 percent top groups include not only German, but also a number of foreign contractors, from the Netherlands, Austria and Switzerland, all of whom use German liner systems, however. German liner manufacturers are therefore gradually succeeding not only in exporting liners „Made in Germany", but also in training the foreign installation crews to a high level.

Conclusion

The annual IKT LinerReport published since 2003/2004 can claim to have tripped off an important debate concerning tube-liner qualities on the German refurbishing market. It continues to be a reliable mirror of current tube-liner quality. The in some cases extremely good success rates in the IKT LinerReport demonstrate independently and impartially that tube-liner technology is rightly the most frequently used refurbishing method.

A look back over the past ten years shows that the installation quality of the tube liners available on the market has improved measurably. Transparency now prevails where clients were previously obliged to rely solely on suppliers' promises. This has driven both product and procedure improvements, and also technical innovations which would not otherwise have occurred. There is now not only price, but also unequivocal quality competition on this market.

The beneficiaries are primarily the clients. They, however, will be well advised to continue consistently requiring quality tests on tube liners for every installation site - there would otherwise be a danger of a creeping retreat from the peak success of 2013.

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