Primus Line®

Submittal Support Document

PRIMUS LINE

The prime solution for pipes.

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1. Company Profile

1.1 Manufacturer of a Unique System for Trenchless Pipe Rehabilitation

A single idea was the spark which stimulated the successful development of Primus Line® – the unique system for the trenchless rehabilitation of pressure pipelines. After intensive development work, the Rädlinger primus line GmbH was founded in 2001 as a part of the Rädlinger Group. Located in Bavaria, it is one of the leading companies in various fields of construction, civil engineering and mechanical engineering in Germany with currently more than 1,800 employees and a turnover of more than 250 million US dollars in 2016.

Embedded in this traditional and privately owned group of companies with great financial strength, Primus Line acts worldwide in the area of trenchless pipe rehabilitation with its unique product for pressurised pipelines. Since its foundation in 2001, the company's network of installation partners for the flexible relining system has grown considerably, as a great number of successfully completed projects around the world show. Today the company, with its headquarters in Germany and subsidiaries in the USA and Australia, has numerous employees who are specialised in the areas of technology and development, production and international sales. Primus Line is also an active member of several industry associations like NASTT, AWWA, CATT, German Water Partnership and AWA.

From the Initial Idea to Success

Primus Line® was developed to react to the recurring, time-consuming and expensive problem of run down pipelines in existing buildings.

Josef Rädlinger already had the idea for using a flexible hose for civil engineering in the 1980s. The hose was to be characterised by flexibility, mobility, light weight and low wall thickness while having the material strength of a steel pipe.

Ten years later, the know-how from the fields of construction, mechanical engineering and weaving technology were combined to find a creative and efficient solution. Together with research and industry partners, Rädlinger experts developed the Primus Line® technology. This technology now sets new standards in the transportation of gases and liquids via pipeline.

The system is based on a woven flexible high-pressure composite pipe and a specially developed connection technique.

Primus Line® products enable the cost-effective trenchless rehabilitation of pressure pipelines for different media such as water, oil and gas. The company's growing international success is based on a clearly defined strategy and excellent products providing cost-saving solutions to a multitude of challenges.

1988 Rädlinger group starts to manufacture circular looms for fire hoses

2001 Foundation of Rädlinger primus line GmbH
Pilot project gas for Verbundnetz Gas AG, Germany

2002 Pilot project gas for Ruhrgas AG, Germany

2003 First Primus Line gas installation for Municipal Utilities Leipzig, Germany

2004 First Primus Line water installation for BASF, Germany
Creation of the test specification VP643 in collaboration with DVGW (German Association for Gas and Water)

2005 First Primus Line oil installation for Exxon Mobil, Germany

2008 Start of production in newly constructed manufacturing plant in Weiding, Germany

2013 Foundation of Primus Line Inc. - first subsidiary in the USA

2016 Foundation of Primus Line Pty Ltd - subsidiary in Australia

2. The Primus Line System

Primus Line® is a flexible sliplining solution for the trenchless rehabilitation of pressure pipelines.

The system consists of a flexible Kevlar®-reinforced liner and specially developed end fittings. The liner is self-supporting and not attached to the host pipe – an annular space remains. Developed by experienced engineers, the system is suitable for different media as well as various other applications and has already proven itself in numerous projects: besides the rehabilitation of damaged pipelines, it can also be used to increase the pressure within existing systems, protect them from corrosion and build bypass systems or stand-alone solutions. The Primus Line® system is certified in many countries – for example Australia, the USA, Germany, Canada and Israel – and meets the highly demanding standards for the transportation of drinking water worldwide. Primus Line® is available in nominal diameters ranging from DN 150 to DN 500 (6 inches to 20 inches).

2.1 Primus Liner

The liner is one of two parts of the Primus Line® system and consists of three different layers, as shown in Figure 1. The outer coating protects the internal load-bearing core structure during the installation process. Regardless of the type of fluid transported, this layer is made of an abrasion-resistant polyethylene (PE). Depending on the required pressure rating, the core structure is made of either one or two layers of seamless woven Kevlar®. The aramid fabric absorbs the pulling force during the insertion of the Primus Liner as well as the operating pressure. Its inner coating varies corresponding to the medium transported.

For drinking water applications, the liner is based on polyethylene (PE) while for its use in the oil and gas industry thermoplastic polyurethane (TPU) is the preferred solution because of the often higher requirements concerning chemical resistance. Due to its composition of multiple layers and a low wall thickness, the Primus Liner unites both flexibility and ultra-high material strength.

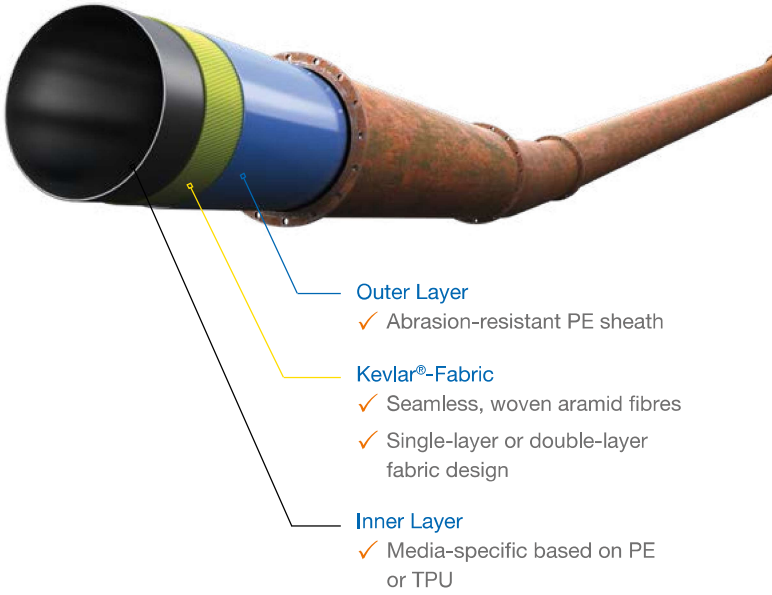


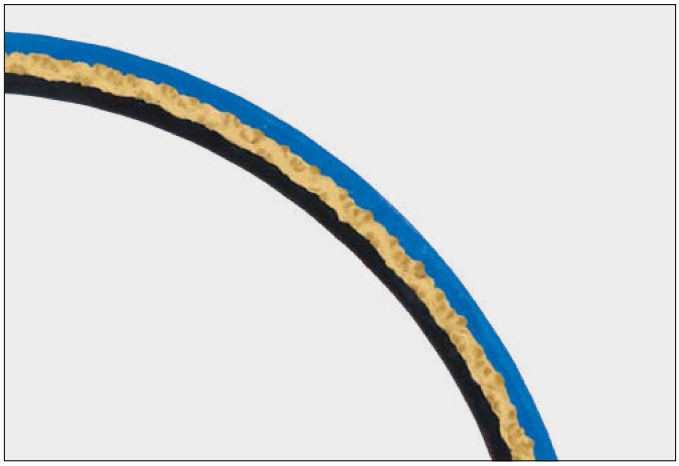
Figure 1: Schematic view of the Primus Liner

2.1.1 Water

Primus Line® provides loss-free and secure conveyance of potable water as well as contaminated or polluted liquids. The composite liner protects the inside of the old pipe against corrosion and abrasive particles situated in the transported media.

Primus Line® is suitable for the transport of the following liquids in the water sector:

- potable water
- firefighting water
- industrial water
- sea water
- waste water



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2.1.2 Gas

Gaseous media present a special challenge to trenchless pipe rehabilitation. However, an inner layer made of low permeation plastics and the seamless production of up to 4,500 m (approx. 14,700 feet) of the Primus Liner have made it possible for gas pipelines to be renovated with Primus Line®. A monitoring pipe with a fitted valve which is attached to the old pipeline allows the observation of the system-specific annular space after the renovation process. The conveyed gas covers media from categories such as natural gases, liquid gases, coke gases and mixed gases (for detailed information please request our **Chemical Resistance Sheet**).

2.1.3 Oil

The oil industry is facing new challenges as a result of increasing damage to steel pipelines caused by internal corrosion. Possible leakages can cause significant environmental problems. They also lead to higher costs or even loss of reputation for network operators. Primus Line® is suitable for the renovation of oil pipelines due to its medium-specific inner layer and acts as a corrosion barrier between the transported fluid and the host pipe. The conveyed fluid covers media from categories such as crude oils, fuel oils, oil slag and other refined products (for detailed information please request our **Chemical Resistance Sheet**).

2.2 Primus Line Connectors

The second part of the Primus Line® system are specially developed termination fittings which are divided into two categories: connectors for low pressure and connectors for medium and high pressure.

2.2.1 Low Pressure Connector

The low pressure connector is a purely mechanical fitting which uses a forming jacket with corresponding contours and can be disassembled for reuse. It is installed with mechanical force to achieve a durable and pull-proof connection. Since no curing process is necessary for the low pressure connector, its installation is quick and a leak test can be performed right afterwards. As a result, considerable time savings are possible. The low pressure connectors are available for liners ranging from DN 150 to DN 300 (6 inches to 12 inches).

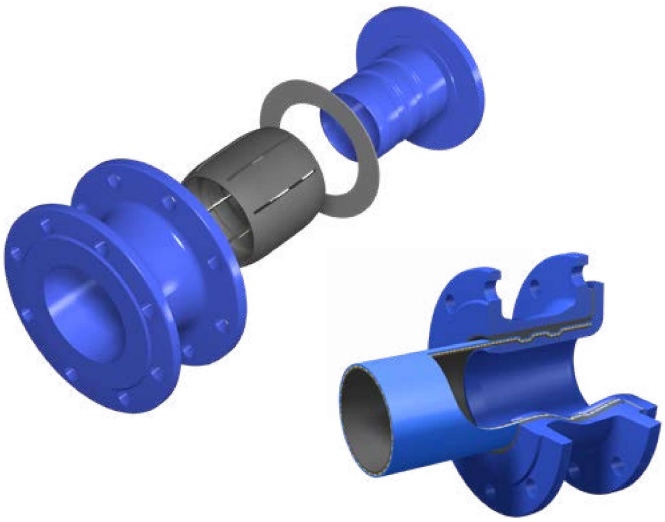


Figure 2: Exploded and general assembly drawing of the low pressure connector

2.2.2 Medium and High Pressure Connector

The medium and high pressure fittings consist of a dimensionally stable profiled internal core and an external sleeve with a deformable metal jacket form, as shown in Figure 3. During the installation, a two-component resin injected through a valve on the external sleeve, forces the metal jacket and consequently the liner into the contours of the internal core. After a curing time of at least 12 hours at 20 °C (68 °F), the connection is permanent and has a high tensile strength as shown in Figure 4. The medium and high pressure fittings are available for all liners from DN 150 to DN 500 (6 inches to 20 inches).

Each end of the Primus Line connectors can be equipped with either a standard flange or a welded end in order to connect it to the host pipe or to enable the integration of a hydrant, service connection or valve. Additionally, it is always possible to provide customised solutions for special applications. More information about this topic is available in chapter 5.10.

Figure 3: Medium-/High-pressure connector prior to the injection of the two-component resin

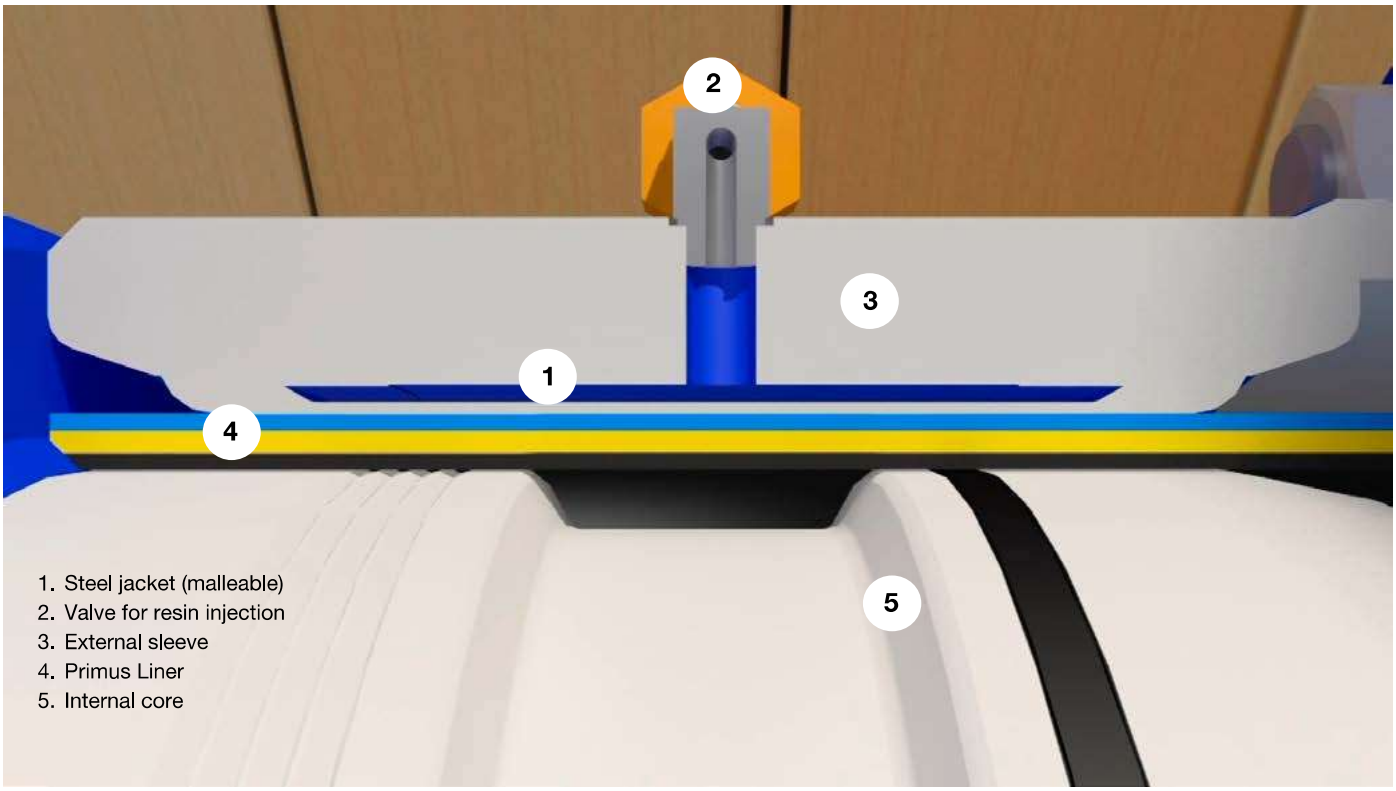
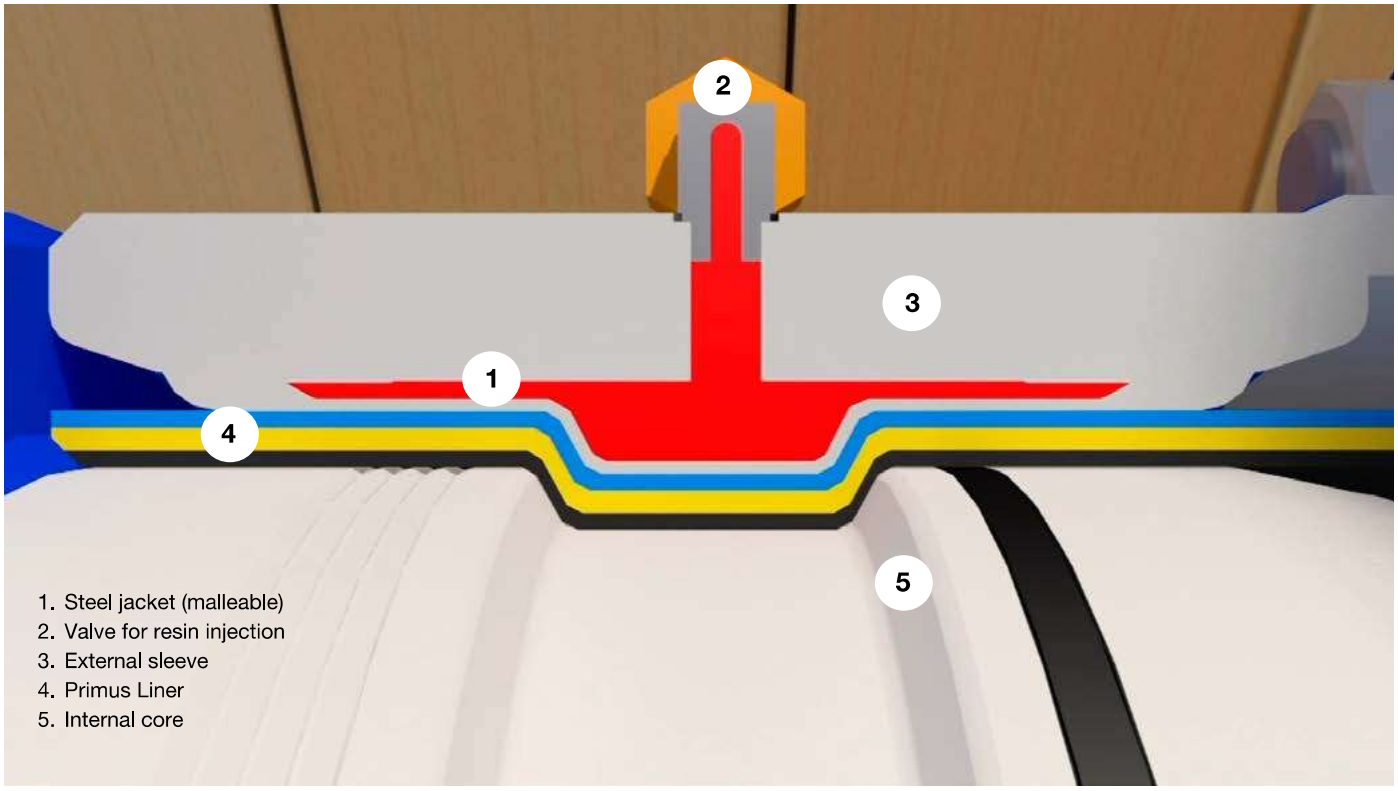


Figure 4: Medium-/High-pressure connector after the injection of the two-component resin



3. The Primus Line Advantage

3.1 Suitability of Primus Line

Currently Primus Line® is more suitable to rehabilitate damaged pressure pipes between DN 150 - DN 500 (6 inches - 20 inches) in diameter with several bends and for installation sections between 300 m and 2,500 m (approx. 1,000 feet - 8,200 feet) in a sensitive or difficult environment quickly and reliably than any other existing system in the world.

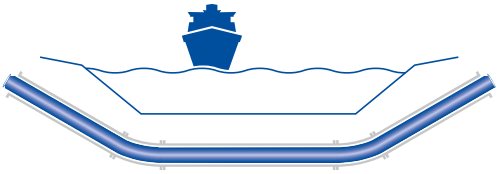
Bend-Traversing Capability

Pipelines often do not run in a straight line. In ailing pipelines this presents an unsolvable task for most pipe rehabilitation systems. With its flexible, multi-layered structure the Primus Liner masters multiple bends of up to 45° with ease. 90° bends can be mastered as well. However any 90° bend has to be evaluated and approved from the technical department.

High-Performance Connectors

Primus Line® connectors are specially developed for the unique system and significantly contribute to its fast installation. They offer an absolutely leak-free and pull-proof connection, a firm assembly onto the host pipe and an easy integration of junctions.

Simple Solution for Inverted Siphons and Difficult Special Projects



A special construction design and/or routing with at least four bends between 0° and 45° and a fast restart of operation are only some of the additional requirements which appear in case of culvert rehabilitation.

In such cases, Primus Line® offers an optimal solution with its characteristics of flexibility, bend traversing capability and simple installation. Other special projects it can be used for are:

- inverted siphons
- bypasses
- pipelines at airports
- chemical plant & refinery pipelines
- pipelines at military bases

Large Lengths Guarantee Cost-Effectiveness in Case of Installation and Transport

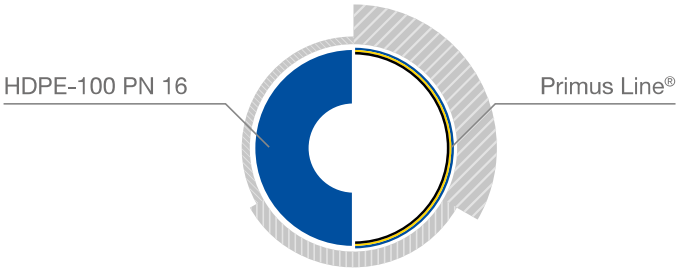
In regard to the installation of the liner and its transport, Primus Line® offers an important characteristic which has significant influence on the cost-effectiveness: the length.

The system allows for unusually large installation lengths of up to 2,500 m (approx. 8,200 feet) which reduce the necessity of construction pits to a minimum and guarantee the lowest possible impact on the environment.

Furthermore, Primus Line® scores with large liner lengths available in one piece on a transport reel (up to 11 m (approx. 36 feet) wide), which enable the transport of up to 5,300 m (approx. 17,300 feet). Together with a reel design that is especially adapted for international shipping by sea and air freight, minimum logistics costs can be achieved.

Hydraulic Capacities for a High Level of Performance on a Long-Term Basis

High-performance pipes and optimum flow-through characteristics are determining factors for the efficiency of line networks and their ability to transport different media rapidly and reliably.



Many rehabilitation methods considerably reduce the inner diameter of a pipeline, which results in a significant loss of hydraulic capacity.

Primus Line® is different: Its small wall thickness of 6 mm to 8 mm (approx. 0.24 inches to 0.32 inches), minimizes the cross-sectional loss and so the capacity of the pipe remains nearly constant. In addition, Primus Line® guarantees improved flow-through characteristics in the pipeline due to the use of optimal materials and ensures the long-term supply by extending the service life of the pipes by at least 50 years.

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Protecting Sensitive and Living Environments

Small construction pits, short rehabilitation times and the low level of environmental intervention make Primus Line® the ideal technology for the rehabilitation of defective lines in sensitive areas.

Regardless of whether highly-frequented streets, nature reserves or sites difficult to access are involved, Primus Line® is exactly the right solution. Pipelines can be renovated easily, rapidly and securely and put into operation again within a very short time.

For both residents and nature, the system offers considerable economic and ecologic advantages:

- no disturbance in street, railroad or shipping traffic
- avoidance of traffic jams
- decrease in noise and pollution by emission
- decrease in road-digging work
- low level of impairment to existing structural fabric
- sustainability through use of existing infrastructure (old piping)
- low impact on landscapes and protected areas
- protection of plants and species

The particular suitability for sensitive environments results from the special installation method of Primus Line® and its simple handling. Installation is possible in the most confined spaces and with a low level of machine employment.

3.2 Benefits of the System

1. Safe & Reliable

a. 100% quality control during the manufacturing process and before shipping

b. no curing, steaming or adhesion process

c. independent of weather conditions during the installation

d. 50+ year lifetime

2. Environmentally Friendly

a. small installation footprint

b. small pits and reduction of road work

c. reduced use of machinery

d. reduced impact on traffic

3. Cost-Effective

a. installation speeds of up to 10 m/min (33 feet/min)

b. up to 2,500 m (approx. 8,200 feet) per pull

c. low pre-investment for installers

d. quick recommissioning for minimal time of service interruption

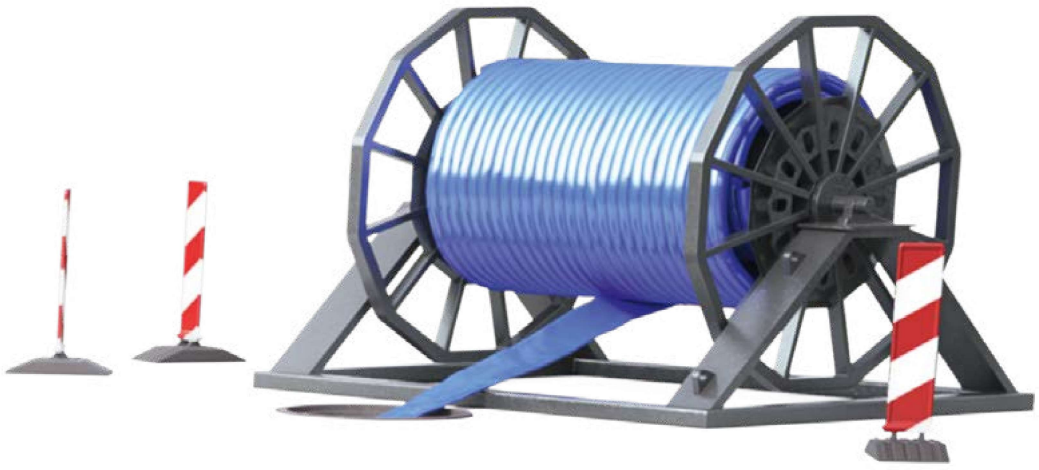
4. Highly Flexible

a. installation through multiple bends of up to 45°

b. withstands thermal expansion of the host pipe and seismic movement

c. fully flexible seamless woven Kevlar® fabric

d. installation in difficult to access areas



3.3 Most Suited Environments

Pipelines often run through environments that are hard to access. Obstacles to an easy and fast rehabilitation of ageing pipes can be of geographical, economical, architectural or environmental nature.

Primus Line® is the trenchless rehabilitation system of choice to easily overcome those obstacles and is uniquely suited for projects in the following areas:

- airports
- river crossings (inverted siphons)
- military bases
- refineries
- bridge crossings
- railway crossings
- environmentally sensitive areas
- congested cities
- high-traffic areas
- chemical plants
- nature parks

Primus Line is most suitable for…

High-traffic Areas

Airports

Cemical Plants & Refineries

Nature Parks

Military Bases

Siphons

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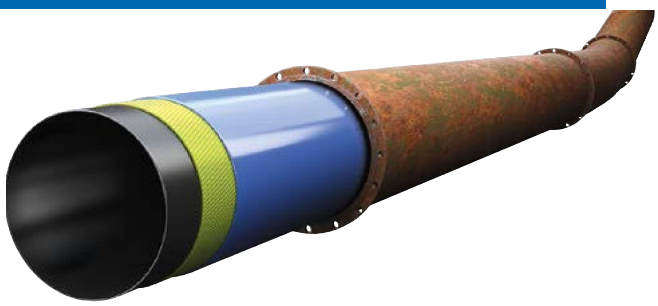
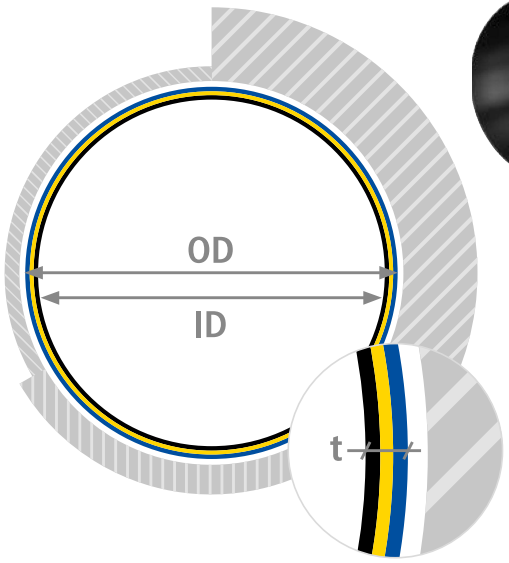
4. The Product

4.1 Product Portfolio

4.1.1 Primus Liner

4.1.1.1 Available Liners





bar	Primus Line® low pressure single-layer hybrid design						Primus Line® medium pressure single-layer Kevlar® design								Primus Line® high pressure double-layer Kevlar® design							
	OD mm	t mm	ID mm	burst bar	MOP water bar	weight water kg/m	OD mm	t mm	ID mm	burst bar	MOP water bar	weight water kg/m	MOP oil/gas bar	weight oil/gas kg/m	OD mm	t mm	ID mm	burst bar	MOP water bar	weight water kg/m	MOP oil/gas bar	weight oil/gas kg/m
Primus Line® DN 150	134	6.0	122	63	25	2.1	134	6.0	122	140	56	2.2	35	2.4	-	-	-	-	-	-	-	-
Primus Line® SD 150	150	6.0	138	54	20	2.4	150	6.0	138	120	48	2.4	30	2.7	160	8.0	144	206	82	3.3	51	3.6
Primus Line® DN 200	182	6.0	170	47	18	2.9	182	6.0	170	100	40	3.0	25	3.3	192	8.0	176	173	69	4.0	43	4.4
Primus Line® SD 203	203	6.0	191	42	16	3.3	203	6.0	191	84	33	3.4	21	3.8	-	-	-	-	-	-	-	-
Primus Line® DN 250	237	6.0	225	38	15	3.8	237	6.0	225	75	30	4.0	18	4.4	250	8.0	234	128	51	5.3	32	5.8
Primus Line® SD 261	261	6.0	249	30	12	4.2	261	6.0	249	64	25	4.4	16	4.9	-	-	-	-	-	-	-	-
Primus Line® DN 300	284	6.0	272	30	12	4.6	284	6.0	272	64	25	4.8	16	5.3	294	8.0	278	110	44	6.4	27	6.9
Primus Line® DN 350	-	-	-	-	-	-	314	6.0	302	50	20	5.2	12	5.9	-	-	-	-	-	-	-	-
Primus Line® DN 400	-	-	-	-	-	-	354	6.0	342	46	18	6.0	11	6.7	364	8.0	348	82	32	8.1	20	8.8
Primus Line® DN 450	-	-	-	-	-	-	408	6.0	396	40	16	7.0	10	7.8	-	-	-	-	-	-	-	-
Primus Line® DN 500	-	-	-	-	-	-	454	6.0	442	40	16	7.7	10	8.6	-	-	-	-	-	-	-	-

The information in this document is based on our current knowledge and experience. Unless specified through a standard, the tests were carried out using internal methods on in-house testing equipment. Tests using other methods or other test equipment might produce different results. As a result of our ongoing development work, we reserve the right to modify products and change the features of the products. The information provided in this document cannot be used to derive any legally binding assurance or warranty for certain properties or the suitability of the product for a specific application.

Primus Liner DN 150, DN 200, DN 250, DN 300 low pressure (water) on stock. Primus Liner DN 150, DN 200, DN 250, DN 300, DN 350, DN 400, DN 450, DN 500 medium pressure (water) on stock.

Remark: The indicated maximum operating pressure (MOP) includes safety factors and is valid for a straight course of the pipe without bends. Maximum operating pressure (MOP) in bends according to specification of the technical department of Rädlinger primus line GmbH.

psi	Primus Line® low pressure single-layer hybrid design						Primus Line® medium pressure single-layer Kevlar® design								Primus Line® high pressure double-layer Kevlar® design							
	OD inch	t inch	ID inch	burst psi	MOP water psi	weight water lbs/ft	OD inch	t inch	ID inch	burst psi	MOP water psi	weight water lbs/ft	MOP oil/gas psi	weight oil/gas lbs/ft	OD inch	t inch	ID inch	burst psi	MOP water psi	weight water lbs/ft	MOP oil/gas psi	weight oil/gas lbs/ft
Primus Line® DN 150/6"	5.28	0.24	4.8	914	363	1.4	5.28	0.24	4.8	2030	812	1.5	508	1.6	-	-	-	-	-	-	-	-
Primus Line® SD 150/6"SD	5.91	0.24	5.43	783	290	1.6	5.91	0.24	5.43	1740	696	1.6	435	1.8	6.3	0.31	5.67	2987	1189	2.2	740	2.4
Primus Line® DN 200/8"	7.17	0.24	6.69	682	261	1.9	7.17	0.24	6.69	1450	580	2	363	2.2	7.56	0.31	6.93	2509	1001	2.7	624	3
Primus Line® SD 203/8"SD	7.99	0.24	7.52	609	232	2.2	7.99	0.24	7.52	1218	479	2.3	305	2.5	-	-	-	-	-	-	-	-
Primus Line® DN 250/10"	9.33	0.24	8.86	551	218	2.6	9.33	0.24	8.86	1088	435	2.7	261	3	9.84	0.31	9.21	1856	740	3.6	464	3.9
Primus Line® SD 261/10"SD	10.28	0.24	9.8	435	174	2.8	10.28	0.24	9.8	928	363	2.9	232	3.3	-	-	-	-	-	-	-	-
Primus Line® DN 300/12"	11.18	0.24	10.71	435	174	3.1	11.18	0.24	10.71	928	363	3.2	232	3.6	11.57	0.31	10.94	1595	638	4.3	392	4.6
Primus Line® DN 350/14"	-	-	-	-	-	-	12.36	0.24	11.89	725	290	3.5	174	3.9	-	-	-	-	-	-	-	-
Primus Line® DN 400/16"	-	-	-	-	-	-	13.94	0.24	13.46	667	261	4	160	4.5	14.33	0.31	13.7	1189	464	5.4	290	5.9
Primus Line® DN 450/18"	-	-	-	-	-	-	16.06	0.24	15.59	580	232	4.7	145	5.2	-	-	-	-	-	-	-	-
Primus Line® DN 500/20"	-	-	-	-	-	-	17.87	0.24	17.4	580	232	5.2	145	5.8	-	-	-	-	-	-	-	-

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4.1.1.2 Pressure Rating in Bends

Nominal diameter in nominal diameter

Computed values for max. operating pressure and max. test pressure are based on „percentage (%) of burst pressure of used Primus Line system“.

Primus Line LP/MP/HP water liners

	max. operating pressure [%] bend radii			max. test pressure [%] bend radii		
α [°]	1.5D	3D	5D	1.5D	3D	5D
0	40.0%	40.0%	40.0%	50.0%	50.0%	50.0%
5	37.5%	37.5%	38.4%	46.9%	46.9%	48.0%
10	35.8%	35.9%	37.3%	44.8%	44.9%	46.7%
15	33.8%	33.9%	36.0%	42.2%	42.4%	45.0%
20	31.5%	31.7%	34.5%	39.4%	39.6%	43.1%
25	29.0%	29.3%	32.7%	36.3%	36.7%	40.9%
30	26.7%	27.1%	30.6%	33.4%	33.9%	38.2%
35	24.7%	25.1%	28.5%	30.8%	31.4%	35.6%
40	23.0%	23.4%	26.6%	28.8%	29.3%	33.3%
45	21.7%	22.1%	25.1%	27.1%	27.6%	31.4%

Primus Line water liners are tested by using potable water.

Primus Line MP/HP gas liners

	max. operating pressure [%] bend radii			max. test pressure [%] bend radii		
α [°]	1.5D	3D	5D	1.5D	3D	5D
0	25.0%	25.0%	25.0%	31.3%	31.3%	31.3%
5	23.4%	23.5%	24.0%	29.3%	29.3%	30.0%
10	22.4%	22.4%	23.3%	28.0%	28.0%	29.2%
15	21.1%	21.2%	22.5%	26.4%	26.5%	28.1%
20	19.7%	19.8%	21.6%	24.6%	24.7%	27.0%
25	18.2%	18.3%	20.4%	22.7%	22.9%	25.5%
30	16.7%	16.9%	19.1%	20.9%	21.2%	23.9%
35	15.4%	15.7%	17.8%	19.3%	19.6%	22.2%
40	14.4%	14.6%	16.6%	18.0%	18.3%	20.8%
45	13.6%	13.8%	15.7%	16.9%	17.3%	19.6%

Primus Line gas liners are tested by using compressed air.

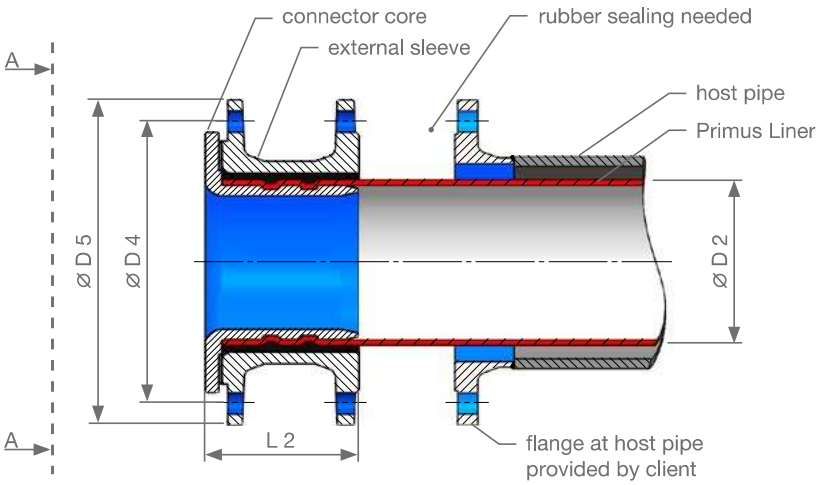
Primus Line MP/HP oil liners

	max. operating pressure [%] bend radii			max. test pressure [%] bend radii		
α [°]	1.5D	3D	5D	1.5D	3D	5D
0	25.0%	25.0%	25.0%	50.0%	50.0%	50.0%
5	23.4%	23.5%	24.0%	46.9%	46.9%	48.0%
10	22.4%	22.4%	23.3%	44.8%	44.9%	46.7%
15	21.1%	21.2%	22.5%	42.2%	42.4%	45.0%
20	19.7%	19.8%	21.6%	39.4%	39.6%	43.1%
25	18.2%	18.3%	20.4%	36.3%	36.7%	40.9%
30	16.7%	16.9%	19.1%	33.4%	33.9%	38.2%
35	15.4%	15.7%	17.8%	30.8%	31.4%	35.6%
40	14.4%	14.6%	16.6%	28.8%	29.3%	33.3%
45	13.6%	13.8%	15.7%	27.1%	27.6%	31.4%

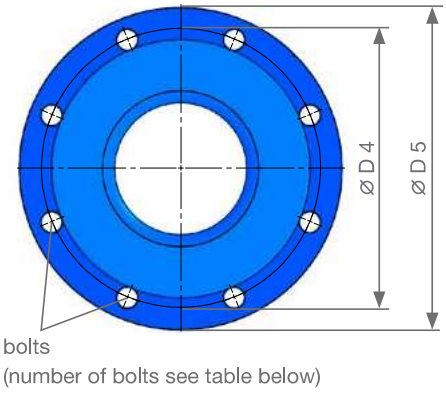
Primus Line oil liners are tested by using potable water.

4.1.2 Primus Line Connectors

Primus Line® low pressure



flange / view A-A



mm/bar Dimensions (EN)

	ø liner	lenght of connector	ø flange of connector				number of bolts			
	LP	LP	PN10	PN16	PN10	PN16	PN10	PN16	PN10	PN16
	D 2 (mm)	L 2 (mm)	D 4 (mm)		D 5 (mm)		pieces		screw thread	
Primus Line® DN 150	134	162	240	240	285	285	8	8	M20	M20
Primus Line® SD 150	150	162	295	295	340	340	8	12	M20	M20
Primus Line® DN 200	182	162	295	295	340	340	8	12	M20	M20
Primus Line® SD 203	203	162	350	355	395	405	12	12	M20	M24
Primus Line® DN 250	237	162	350	355	405	405	12	12	M20	M24
Primus Line® SD 261	261	162	400	410	445	460	12	12	M20	M24
Primus Line® DN 300	284	162	400	410	460	460	12	12	M20	M24

inch/psi Dimensions (EN)

	ø liner	lenght of connector	ø flange of connector				number of bolts			
	LP	LP	145 psi	232 psi	145 psi	232 psi	145 psi	232 psi	145 psi	232 psi
	D 2 (inch)	L 2 (inch)	D 4 (inch)		D 5 (inch)		pieces		screw thread	
Primus Line® DN 150/6''	5.28	6.38	9.44	9.44	11.22	11.22	8	8	3/4''	3/4''
Primus Line® SD 150/6''SD	5.91	6.38	11.61	11.61	13.38	13.38	8	12	3/4''	3/4''
Primus Line® DN 200/8''	7.17	6.38	11.61	11.61	13.38	13.38	8	12	3/4''	3/4''
Primus Line® SD 203/8''SD	7.99	6.38	13.78	13.98	15.55	15.94	12	12	3/4''	7/8''
Primus Line® DN 250/10''	9.33	6.38	13.78	13.98	15.94	15.94	12	12	3/4''	7/8''
Primus Line® SD 261/10''SD	10.28	6.38	15.74	16.14	17.52	18.11	12	12	3/4''	7/8''
Primus Line® DN 300/12''	11.18	6.38	15.74	16.14	18.11	18.11	12	12	3/4''	7/8''

mm/#150 Dimensions (ANSI)

	ø liner	lenght of connector	ø flange of connector		number of bolts	
	LP	LP	#150	#150	pieces	screw thread
	D 2 (mm)	L 2 (mm)	D 4 (mm)	D 5 (mm)		
Primus Line® DN 150/6''	134	162	241.3	280	8	3/4''
Primus Line® SD 150/6''SD	150	162	298.4	342.9	8	3/4''
Primus Line® DN 200/8''	182	162	298.4	345	8	3/4''
Primus Line® SD 203/8''SD	203	162	361.9	406.4	12	7/8''
Primus Line® DN 250/10''	237	162	361.9	405	12	7/8''
Primus Line® SD 261/10''SD	261	162	431.8	482.6	12	7/8''
Primus Line® DN 300/12''	284	162	431.8	485	12	7/8''

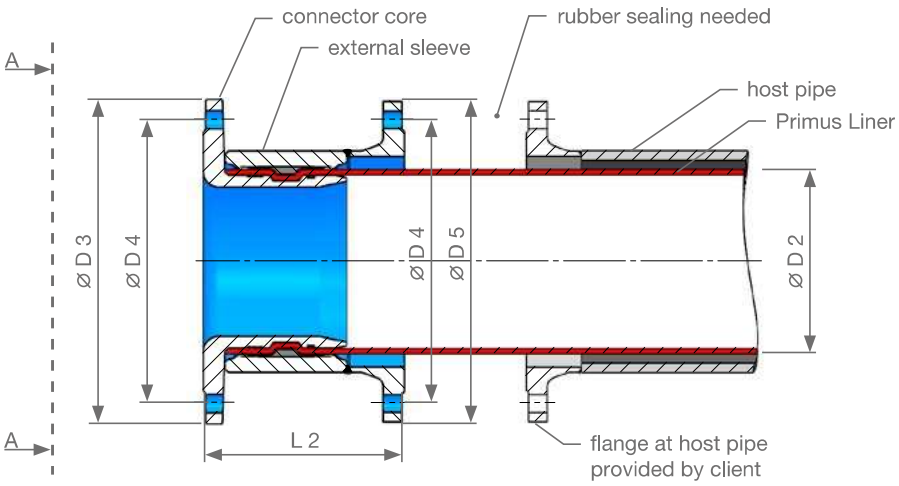
inch/#150 Dimensions (ANSI)

	ø liner	lenght of connector	ø flange of connector		number of bolts	
	LP	LP	#150	#150	pieces	screw thread
	D 2 (inch)	L 2 (inch)	D 4 (inch)	D 5 (inch)		
Primus Line® DN 150/6''	5.28	6.38	9.50	11.02	8	3/4''
Primus Line® SD 150/6''SD	5.91	6.38	11.75	13.50	8	3/4''
Primus Line® DN 200/8''	7.17	6.38	11.75	13.58	8	3/4''
Primus Line® SD 203/8''SD	7.99	6.38	14.25	16.00	12	7/8''
Primus Line® DN 250/10''	9.33	6.38	14.25	15.94	12	7/8''
Primus Line® SD 261/10''SD	10.28	6.38	17.00	19.00	12	7/8''
Primus Line® DN 300/12''	11.18	6.38	17.00	19.09	12	7/8''

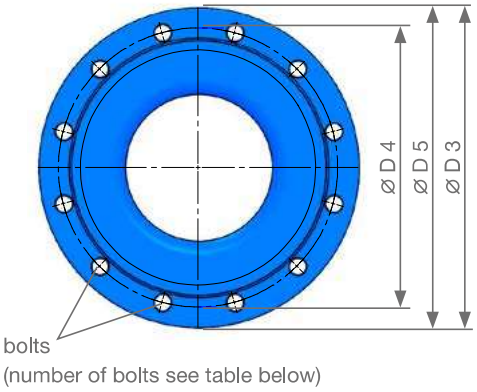
mm/bar Dimensions (AS)

	ø liner	lenght of connector	ø flange of connector		number of bolts	
	LP	LP	PN16	PN16	PN16	PN16
	D 2 (mm)	L 2 (mm)	D 4 (mm)	D 5 (mm)	pieces	screw thread
Primus Line® DN 150	134	162	235	285	8	M16
Primus Line® SD 150	150	162	292	340	8	M16
Primus Line® DN 200	182	162	292	340	8	M16
Primus Line® SD 203	203	162	356	405	8	M20
Primus Line® DN 250	237	162	356	405	8	M20
Primus Line® SD 261	261	162	406	460	12	M20
Primus Line® DN 300	284	162	406	460	12	M20

Primus Line® medium pressure



flange / view A-A



mm/bar Dimensions (EN)

	ø liner	lenght of connector		ø flange of core		ø bolt circle		ø flange at external sleeve		number of bolts			
	MP	PN10	PN16	PN10	PN16	PN10	PN16	PN10	PN16	PN10	PN16	PN10	PN16
	D 2 (mm)	L 2 (mm)		D 3 (mm)		D 4 (mm)		D 5 (mm)		pieces		screw thread	
Primus Line® DN 150	134	233	233	285	285	240	240	285	285	8	8	M20	M20
Primus Line® SD 150	150	176	176	340	340	295	295	340	340	8	12	M20	M20
Primus Line® DN 200	182	241	241	340	340	295	295	340	340	8	12	M20	M20
Primus Line® SD 203	203	178	178	400	400	350	355	395	405	12	12	M20	M24
Primus Line® DN 250	237	250	252	400	400	350	355	395	405	12	12	M20	M24
Primus Line® SD 261	261	180	180	455	455	400	410	445	460	12	12	M20	M24
Primus Line® DN 300	284	252	262	455	455	400	410	445	460	12	12	M20	M24
Primus Line® DN 350	314	253	267	520	520	460	470	505	520	16	16	M20	M24
Primus Line® DN 400	354	311	324	580	580	515	525	565	580	16	16	M24	M27
Primus Line® DN 450	408	312	323	640	640	565	585	615	640	20	20	M24	M27
Primus Line® DN 500	454	317	326	715	715	620	650	670	715	20	20	M24	M30

inch/psi Dimensions (EN)

	ø liner	lenght of connector		ø flange of core		ø bolt circle		ø flange at external sleeve		number of bolts			
	MP	145 psi	232 psi	145 psi	232 psi	145 psi	232 psi	145 psi	232 psi	145 psi	232 psi	145 psi	232 psi
	D 2 (inch)	L 2 (inch)		D 3 (inch)		D 4 (inch)		D 5 (inch)		pieces		screw thread	
Primus Line® DN 150/6''	5.28	9.17	9.17	11.22	11.22	9.45	9.45	11.22	11.22	8	8	3/4''	3/4''
Primus Line® SD 150/6''SD	5.91	6.93	6.93	13.39	13.39	11.61	11.61	13.39	13.39	8	12	3/4''	3/4''
Primus Line® DN 200/8''	7.17	9.49	9.49	13.39	13.39	11.61	11.61	13.39	13.39	8	12	3/4''	3/4''
Primus Line® SD 203/8''SD	7.99	7.01	7.01	15.75	15.75	13.78	13.98	15.55	15.94	12	12	3/4''	7/8''
Primus Line® DN 250/10''	9.33	9.84	9.92	15.75	15.75	13.78	13.98	15.55	15.94	12	12	3/4''	7/8''
Primus Line® SD 261/10''SD	10.28	7.09	7.09	17.91	17.91	15.75	16.14	17.52	18.11	12	12	3/4''	7/8''
Primus Line® DN 300/12''	11.18	9.92	10.3	17.91	17.91	15.75	16.14	17.52	18.11	12	12	3/4''	7/8''
Primus Line® DN 350/14''	12.36	9.96	10.51	20.47	20.47	18.11	18.50	19.88	20.47	16	16	3/4''	7/8''
Primus Line® DN 400/16''	13.94	12.24	12.76	22.83	22.83	20.28	20.67	22.24	22.83	16	16	7/8''	1''
Primus Line® DN 450/18''	16.06	12.28	12.71	25.20	25.20	22.24	23.03	24.21	25.20	20	20	7/8''	1''
Primus Line® DN 500/20''	17.87	12.48	12.83	28.15	28.15	24.41	25.59	26.38	28.15	20	20	7/8''	1 1/8''

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mm/#150 or #300 Dimensions (ANSI)

	ø liner	lenght of connector		ø flange of core		ø bolt circle		ø flange at extrenal sleeve		number of bolts			
	MP	#150	#300	#150	#300	#150	#300	#150	#300	#150	#300	#150	#300
	D 2 (mm)	L 2 (mm)		D 3 (mm)		D 4 (mm)		D 5 (mm)		pieces		screw thread	
Primus Line® DN 150/6''	134	269	289	279.4	317.5	241.3	269.9	279.4	317.5	8	12	3/4''	3/4''
Primus Line® SD 150/6''SD	150	180	192	342.9	381	298.4	330.2	342.9	381	8	12	3/4''	7/8''
Primus Line® DN 200/8''	182	285	307	342.9	381	298.4	330.2	342.9	381	8	12	3/4''	7/8''
Primus Line® SD 203/8''SD	203	182	198	406.4	444.5	361.9	287.3	406.4	444.5	12	16	7/8''	1''
Primus Line® DN 250/10''	237	286	318	406.4	444.5	361.9	287.3	406.4	444.5	12	16	7/8''	1''
Primus Line® SD 261/10''SD	261	183	201	482.6	520.7	431.8	450.8	482.6	520.7	12	16	7/8''	1 1/8''
Primus Line® DN 300/12''	284	301	334	482.6	520.7	431.8	450.8	482.6	520.7	12	16	7/8''	1 1/8''
Primus Line® DN 350/14''	314	316	350	533.4	584.2	476.2	514.3	533.4	584.2	12	20	1''	1 1/8''
Primus Line® DN 400/16''	354	368	408	596.9	647.7	539.7	571.5	596.9	647.7	16	20	1''	1 1/4''
Primus Line® DN 450/18''	408	384	422	635	711.2	577.8	628.8	635	711.2	16	24	1 1/8''	1 1/4''
Primus Line® DN 500/20''	454	392	427	698.5	774.7	635	658.8	698.5	774.7	20	24	1 1/8''	1 1/4''

inch/#150 or #300 Dimensions (ANSI)

	ø liner	lenght of connector		ø flange of core		ø bolt circle		ø flange at external sleeve		number of bolts			
	MP	#150	#300	#150	#300	#150	#300	#150	#300	#150	#300	#150	#300
	D 2 (inch)	L 2 (inch)		D 3 (inch)		D 4 (inch)		D 5 (inch)		pieces		screw thread	
Primus Line® DN 150/6''	5.28	10.59	11.38	11.00	12.50	9.50	10.63	11.00	12.50	8	12	3/4''	3/4''
Primus Line® SD 150/6''SD	5.91	7.09	7.56	13.50	15.00	11.75	13.00	13.50	15.00	8	12	3/4''	7/8''
Primus Line® DN 200/8''	7.17	11.22	12.09	13.50	15.00	11.75	13.00	13.50	15.00	8	12	3/4''	7/8''
Primus Line® SD 203/8''SD	7.99	7.16	7.8	16.00	17.50	14.25	11.31	16.00	17.50	12	16	7/8''	1''
Primus Line® DN 250/10''	9.33	11.26	12.52	16.00	17.50	14.25	11.31	16.00	17.50	12	16	7/8''	1''
Primus Line® SD 261/10''SD	10.28	7.2	7.91	19.00	20.50	17.00	17.75	19.00	20.50	12	16	7/8''	1 1/8''
Primus Line® DN 300/12''	11.18	11.85	13.15	19.00	20.50	17.00	17.75	19.00	20.50	12	16	7/8''	1 1/8''
Primus Line® DN 350/14''	12.36	12.44	13.78	21.00	23.00	18.75	20.25	21.00	23.00	12	20	1''	1 1/8''
Primus Line® DN 400/16''	13.94	14.49	16.06	23.50	25.50	21.25	22.50	23.50	25.50	16	20	1''	1 1/4''
Primus Line® DN 450/18''	16.06	15.12	16.61	25.00	28.00	22.75	27.76	25.00	28.00	16	24	1 1/8''	1 1/4''
Primus Line® DN 500/20''	17.87	15.43	16.81	27.50	30.50	25.00	25.94	27.50	30.50	20	24	1 1/8''	1 1/4''

mm/bar Dimensions (AS)

	ø liner	lenght of connector	ø flange of core	ø bolt circle	ø flange at external sleeve	number of bolts	
	MP	PN16	PN16	PN16	PN16	PN16	PN16
	D 2 (mm)	L 2 (mm)	D 3 (mm)	D 4 (mm)	D 5 (mm)	pieces	screw thread
Primus Line® DN 150	134	175	285	235	280	8	M16
Primus Line® SD 150	150	176	335	292	336	8	M16
Primus Line® DN 200	182	176	340	292	335	8	M16
Primus Line® SD 203	203	178	405	356	405	8	M20
Primus Line® DN 250	237	179	400	356	405	8	M20
Primus Line® SD 261	261	180	455	406	455	12	M20
Primus Line® DN 300	284	181	455	406	455	12	M20
Primus Line® DN 350	314	182	520	470	520	12	M24
Primus Line® DN 400	354	236	580	521	580	12	M24
Primus Line® DN 450	408	237	640	584	640	12	M24
Primus Line® DN 500	454	239	715	641	705	16	M24

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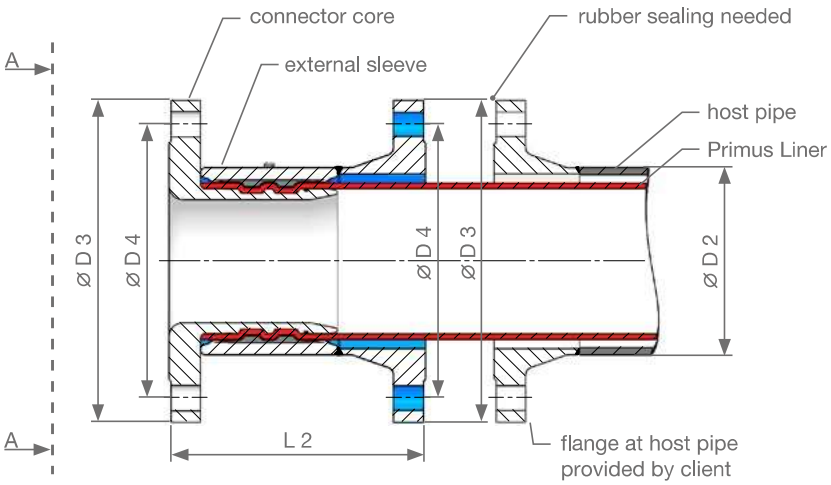
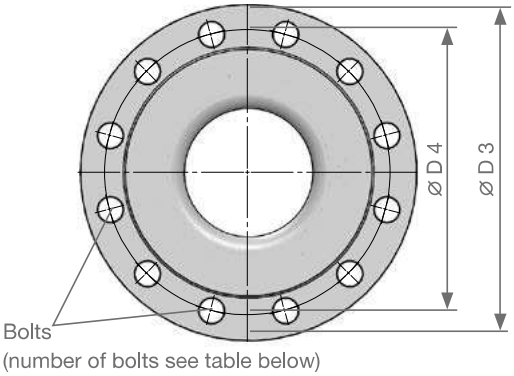
Primus Line® high pressure



flange / view A-A



mm/bar Dimensions (EN)

	ø liner	lenght of connector				ø flange				ø bolt circle				number of bolts							
	HP	PN25	PN40	PN63	PN100	PN25	PN40	PN63	PN100	PN25	PN40	PN63	PN100	PN25	PN40	PN63	PN100	PN25	PN40	PN63	PN100
	D 2 (mm)	L 2 (mm)				D 3 (mm)				D 4 (mm)				pieces				screw thread			
Primus Line® SD 150	160	231	235	243	253	360	375	415	430	310	320	345	360	12	12	12	12	M24	M27	M33	M33
Primus Line® DN 200	192	314	326	356	386	360	375	415	430	310	320	345	360	12	12	12	12	M24	M27	M33	M33
Primus Line® DN 250	250	324	347	375	-	425	450	470	-	370	385	400	-	12	12	12	-	M27	M30	M33	-
Primus Line® DN 300	294	330	361	396	-	485	515	530	-	430	450	460	-	16	16	16	-	M27	M30	M33	-
Primus Line® DN 400	364	354	389	-	-	620	660	-	-	550	585	-	-	16	16	-	-	M33	M36	-	-

inch/psi Dimensions (EN)

	ø liner	lenght of connector				ø flange				ø bolt circle				number of bolts							
	HP	362psi	580psi	914psi	1450psi	362psi	580psi	914psi	1450psi	362psi	580psi	914psi	1450psi	362psi	580psi	914psi	1450psi	362psi	580psi	914psi	1450psi
	D 2 (inch)	L 2 (inch)				D 3 (inch)				D 4 (inch)				pieces				screw thread			
Primus Line® SD 150/6'' SD	6.3	9.09	9.25	9.57	9.96	14.17	14.76	16.34	16.93	12.2	12.6	13.58	14.17	12	12	12	12	7/8''	1''	1 1/4''	1 1/4''
Primus Line® DN 200/8''	7.56	12.36	12.83	14.02	15.2	14.17	14.76	16.34	16.93	12.2	12.6	13.58	14.17	12	12	12	12	7/8''	1''	1 1/4''	1 1/4''
Primus Line® DN 250/10''	9.84	12.76	13.66	14.76	-	16.73	17.72	18.5	-	14.57	15.16	15.75	-	12	12	12	-	1''	1 1/8''	1 1/4''	-
Primus Line® DN 300/12''	11.57	12.99	14.21	15.59	-	19.09	20.28	20.87	-	16.93	17.72	18.11	-	16	16	16	-	1''	1 1/8''	1 1/4''	-
Primus Line® DN 400/16''	14.33	13.94	15.32	-	-	24.41	25.98	-	-	21.65	23.03	-	-	16	16	-	-	1 1/4''	1 3/8''	-	-

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PRIMUS LINE
The prime solution for pipes.

mm/#150 Dimensions (ANSI)

	ø liner	lenght of connector		ø flange		ø bolt circle		number of bolts			
	HP	#150	#300	#150	#300	#150	#300	#150	#300	#150	#300
	D 2 (mm)	L 2 (mm)		D 3 (mm)		D 4 (mm)		pieces		screw thread	
Primus Line® SD 150/6'' SD	160	230	242	342.9	381	298.4	330.2	8	12	3/4''	7/8''
Primus Line® DN 200/8''	192	334	356	342.9	381	298.4	330.2	8	12	3/4''	7/8''
Primus Line® DN 250/10''	250	336	369	406.4	444.5	361.9	387.3	12	16	7/8''	1''
Primus Line® DN 300/12''	294	350	385	482.6	520.7	431.8	450.8	12	16	7/8''	1 1/8''
Primus Line® DN 400/16''	364	367	407	596.9	647.7	539.7	571.5	16	20	1''	1 1/4''

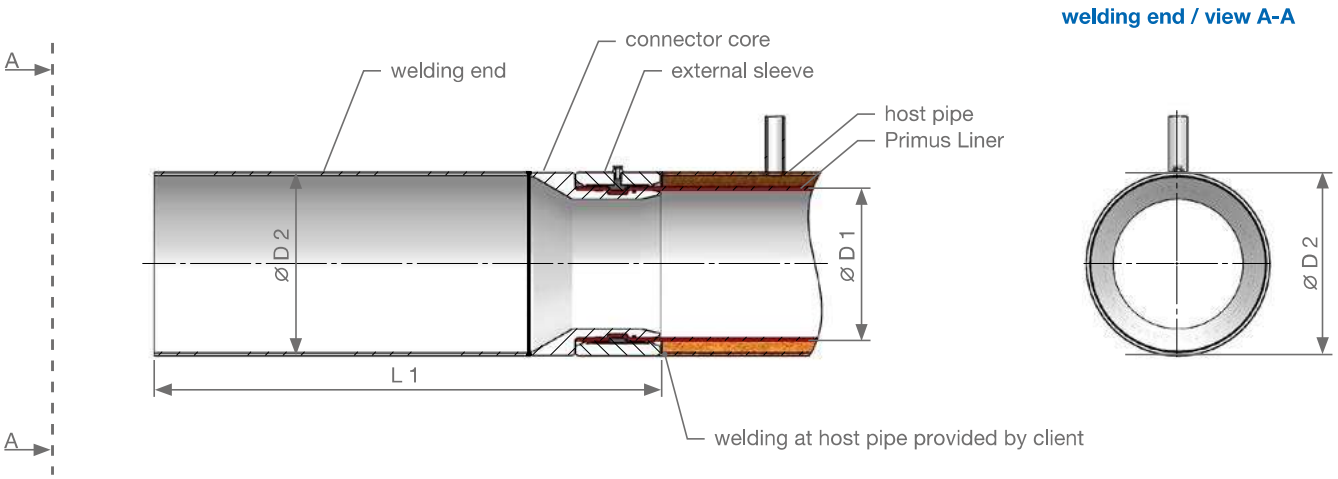
inch/#150 Dimensions (ANSI)

	ø liner	lenght of connector		ø flange		ø bolt circle		number of bolts			
	HP	#150	#300	#150	#300	#150	#300	#150	#300	#150	#300
	D 2 (inch)	L 2 (inch)		D 3 (inch)		D 4 (inch)		pieces		screw thread	
Primus Line® SD 150/6'' SD	6.3	9.04	9.53	13.5	15	11.75	13	8	12	3/4''	7/8''
Primus Line® DN 200/8''	7.56	13.15	14.02	13.5	15	11.75	13	8	12	3/4''	7/8''
Primus Line® DN 250/10''	9.84	13.22	14.53	16	17.5	14.25	15.25	12	16	7/8''	1''
Primus Line® DN 300/12''	11.57	13.78	15.16	19	20.5	17	17.75	12	16	7/8''	1 1/8''
Primus Line® DN 400/16''	14.33	14.46	16.03	23.5	25.5	21.25	22.5	16	20	1''	1 1/4''

mm/bar Dimensions (AS)

	ø liner	lenght of connector	ø flange	ø bolt circle	number of bolts	
	HP	PN16	PN16	PN16	PN16	PN16
	D 2 (mm)	L 2 (mm)	D 3 (mm)	D 4 (mm)	pieces	screw thread
Primus Line® SD 150	160	225	335	292	8	M16
Primus Line® DN 200	192	225	335	292	8	M16
Primus Line® DN 250	250	227	405	356	8	M20
Primus Line® DN 300	294	229	455	406	12	M20
Primus Line® DN 400	364	233	580	521	12	M24

Connector with welded ends



mm/bar Dimensions

	ø liner		lenght of connector		ø welding end	
	MP	HP	MP	HP	MP	HP
	D 1 (mm)		L 1 (mm)		D 2 (mm)	
Primus Line® DN 150	134	-	888	-	168	-
Primus Line® DN 200	182	192	893	945	219	219
Primus Line® DN 250	237	250	893	948	273	273
Primus Line® DN 300	284	294	893	948	324	324
Primus Line® DN 350	314	-	893	-	356	-
Primus Line® DN 400	354	364	963	963	406	406
Primus Line® DN 450	408	-	963	-	457	-
Primus Line® DN 500	454	-	963	-	508	-

inch/psi Dimensions

	ø liner		lenght of connector		ø welding end	
	MP	HP	MP	HP	MP	HP
	D 1 (mm)		L 1 (mm)		D 2 (mm)	
Primus Line® DN 150	5.28	-	34.96	-	6.61	-
Primus Line® DN 200	7.17	7.56	35.16	37.2	8.62	8.62
Primus Line® DN 250	9.33	9.87	35.16	37.32	10.75	10.75
Primus Line® DN 300	11.18	11.57	35.16	37.32	12.76	12.76
Primus Line® DN 350	12.36	-	35.16	-	14.02	-
Primus Line® DN 400	13.94	14.33	37.91	37.91	15.98	15.98
Primus Line® DN 450	16.06	-	37.91	-	18	-
Primus Line® DN 500	17.87	-	37.91	-	20	-

4.1.3 Transport reel capacity

flat Liner (all capacity values in meters)											
Drum Type	Nominal Size										
	DN 150	150 SD	DN 200	203 SD	DN 250	261 SD	DN 300	DN 350	DN 400	DN 450	DN 500
T-110	631	561	465	415	360	328	300	100	100	101	101
T-210	1.194	1.062	880	786	682	621	568	513	454	389	352
T-300	1.447	1.288	1.067	953	826	753	689	623	551	472	426
T-400	2.045	1.819	1.508	1.346	1.168	1.064	974	880	779	667	603
T-500	2.577	2.293	1.900	1.697	1.472	1.341	1.227	1.109	981	840	760
T-600	3.110	2.767	2.293	2.047	1.776	1.618	1.481	1.338	1.184	1.014	917
T-800	4.154	3.696	3.063	2.735	2.372	2.162	1.978	1.787	1.582	1.354	1.224
T-1100	5.751	5.117	4.240	3.786	3.284	2.993	2.739	2.474	2.190	1.875	1.695

folded Liner (all capacity values in meters)											
Drum Type	Nominal Size										
	DN 150	150 SD	DN 200	203 SD	DN 250	261 SD	DN 300	DN 350	DN 400	DN 450	DN 500
T-110	618	550	456	407	353	322	295	266	236	202	182
T-210	1.169	1.041	863	771	668	609	558	504	446	382	345
T-300	1.418	1.262	1.046	934	810	739	676	611	541	463	419
T-400	2.004	1.783	1.478	1.320	1.145	1.044	955	863	764	654	591
T-500	2.525	2.247	1.863	1.664	1.444	1.316	1.204	1.088	963	824	746
T-600	3.047	2.712	2.248	2.008	1.742	1.588	1.453	1.313	1.162	995	900
T-800	4.070	3.622	3.003	2.682	2.326	2.120	1.941	1.753	1.552	1.329	1.201
T-1100	5.635	5.015	4.157	3.713	3.221	2.936	2.687	2.428	2.149	1.840	1.664

flat Liner (all capacity values in feet)											
Drum Type	Nominal Size										
	DN 150	150 SD	DN 200	203 SD	DN 250	261 SD	DN 300	DN 350	DN 400	DN 450	DN 500
T-110	2.069	1.841	1.525	1.362	1.181	1.077	985	328	329	332	333
T-210	3.916	3.484	2.887	2.578	2.236	2.038	1.865	1.685	1.491	1.276	1.154
T-300	4.748	4.224	3.501	3.126	2.711	2.471	2.261	2.043	1.808	1.548	1.399
T-400	6.709	5.969	4.947	4.417	3.831	3.491	3.195	2.886	2.554	2.187	1.977
T-500	8.456	7.524	6.235	5.567	4.829	4.400	4.027	3.638	3.220	2.756	2.492
T-600	10.203	9.078	7.523	6.717	5.826	5.310	4.859	4.390	3.885	3.326	3.007
T-800	13.627	12.125	10.048	8.972	7.782	7.092	6.490	5.863	5.189	4.442	4.016
T-1100	18.869	16.788	13.912	12.423	10.775	9.819	8.986	8.118	7.184	6.151	5.561

folded Liner (all capacity values in feet)											
Drum Type	Nominal Size										
	DN 150	150 SD	DN 200	203 SD	DN 250	261 SD	DN 300	DN 350	DN 400	DN 450	DN 500
T-110	2.027	1.804	1.495	1.336	1.159	1.056	967	873	773	662	598
T-210	3.837	3.415	2.831	2.528	2.193	1.999	1.829	1.653	1.463	1.253	1.133
T-300	4.652	4.140	3.432	3.065	2.659	2.424	2.218	2.004	1.774	1.519	1.373
T-400	6.573	5.850	4.850	4.331	3.757	3.425	3.134	2.832	2.507	2.146	1.941
T-500	8.285	7.374	6.113	5.459	4.736	4.317	3.951	3.569	3.159	2.705	2.446
T-600	9.997	8.897	7.376	6.587	5.714	5.208	4.767	4.307	3.812	3.264	2.951
T-800	13.352	11.883	9.851	8.798	7.632	6.956	6.367	5.752	5.091	4.359	3.942
T-1100	18.487	16.454	13.640	12.182	10.568	9.632	8.816	7.965	7.050	6.036	5.458

- lists valid for medium and low pressure liner
- for high pressure liner length must be multiplied by a factor of 0.85
- list valid for oil, gas and water liner
- drum suitable for transportation in ISO container

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4.2 Material

4.2.1 Primus Liner

The Primus Liner is manufactured out of up to three different materials: aramid fabric, polyethylene and – depending on the application – thermoplastic polymer.

The aramid fabric produced from aramid fibres has a seamless, continuous twill. While the polyethylene material used in the inner layer of the Primus Liner is black in appearance, its outer layer is individual and identifies its application. The Primus Liner has sufficient UV resistance to protect its barrier layer from deleterious UV exposure effects during unprotected outdoor shipping and storage.

Primus Line only uses virgin material in a form such as granules that has not been subjected to use or processing other than that required for its manufacture and to which no rework or recyclable materials have been added.

The Primus Liner is clearly marked with the following information:

- the nominal composite liner diameter
- the fluid and MOP (Maximum Operating Pressure) for the transported fluid
- the trade name/trademark
- the day, month and year of manufacture in the format DDMMYYYY
- Primus Line batch number
- the continuous production run length in metres

For shipment all Primus Liners are spooled onto transport reels. All Primus Liners must be handled in accordance to the Primus Line Installation Manual.

4.2.2 Primus Line Connectors

Primus Line connectors are manufactured from either cast iron, carbon steel or stainless steel. They meet the requirements of following specifications:

	DIN	EN	ASTM
cast iron	5.3200	EN-GJS-500-7	A395
carbon steel	1.0576	S355J2H	(S355J2H)
stainless steel	1.4462	X2CrNiMoN22-5-3	A182 F51

Connectors are both available with flanges or welding ends. While models with welding ends are not coated, models with flanges have a full-surface, high quality powder coating, which provides corrosion protection on all sides. The internal core of the high pressure connector is made of stainless steel. Flanges used by Primus Line comply with either EN 1092, ANSI B16.5 or AS 4087. All connectors preserve the overall integrity and function of the liner.

The Primus Line® system is designed for high pull-out resistance and in such a way that in the event of a failure damage occurs in the liner wall and not within the fitting/liner assembly.

Primus Line recommends the installation of the system in accordance to its comprehensive installation manual.

4.3 Performance and Testing

In collaboration with DVGW (German Association for Gas and Water) Primus Line developed the test specifications VP 643, which are complemented by a separate factory standard established over the past 10 years. These are the basis for Primus Line's quality measures. Primus Line® is subject to a continuous quality control with opto-electronic measurement tools during the entire manufacturing process. An external test lab strictly monitors the adherence to the guidelines of VP 643 required for obtaining the DVGW type approval certificate in half-yearly inspections.

Primus Line employs various test methods after each production batch to achieve highest quality standards. The data from Short-term Burst Pressure Tests allows for a reliable calculation of the maximum allowable operating pressure.

Combined with results from Longterm Hydrostatic Verification Primus Line extrapolates the stress on the liner over a time span of 50 years and verifies its durability.

5. Design Guidelines

5.1 General Design

The Primus Line® system can be deployed for pressurized applications only and is not suitable for gravity pipes. The system is installed into an existing host pipe with an annular space. The Primus Line® system is considered a self-supporting system that accommodates the entire operating pressure independently from the host pipe, however requires the host pipe for external loading.

5.2 Fluid Compatibility and Chemical Resistance

The Primus Line® system is suitable for the transport of different fluids including, but not limited to, potable water, raw water, brine, natural gas, diesel, and residential waste water. The inner coating of the liner that is in contact with the transported fluid has to be selected according to the attached Chemical Resistance Sheet. Further applications and their suitability have to be reviewed by the manufacturer. The following hygienic certifications and many more are available:

DVGW CERT

DVGW type examination certificate

DVGW-Baumusterprüfzertifikat

DG-8955BP0476

Field of Application *Anwendungsbereich*	products of gas supply *Produkte der Gasversorgung*
Owner of Certificate *Zertifikatinhaber*	Rädlinger primus line GmbH Kammerdorfer Straße 16, D-93413 Cham
Distributor *Vertreiber*	Rädlinger primus line GmbH Kammerdorfer Straße 16, D-93413 Cham
Product Category *Produktart*	tube inside coating procedure; sealing and hose relining procedures for supply pipes (8955)
Product Description *Produktbezeichnung*	flexible textil-reinforced plastic inliner for pipe-relining of gas high pressure pipes
Model *Model*	Primus Line®
Test Reports *Prüfberichte*	laboratory control test: K16/05/0662 from 27.05.2016 (DBI)
Test Basis *Prüfgrundlagen*	DVGW VP 643 (01.06.2004)
Date of Expiry / File No. *Ablaufdatum / Aktenzeichen*	29.09.2019 / 16-0584-GNV

11.08.2016 Rie A-1/2

DAkkS Deutsche Akkreditierungsstelle D-ZE-16026-01-05

CSA Group

Certificate of Compliance

Certificate: 2588210 **Master Contract:** 257316 (257316)

Project: 70163845 **Date Issued:** 2017-12-21

Issued to: **Raedlinger Primus Line GmbH**
Kammerdorfer Str. 16
Cham, Bayern 93413
GERMANY
Attention: Andreas Muehlbauer

The products listed below are eligible to bear the CSA Mark shown with adjacent indicators 'C' and 'US'

C US Drinking Water
NSF/ANSI 61

Issued by: Brook Hatton
Brook Hatton

PRODUCTS
CLASS - C686105 - BARRIER MATERIALS - NSF/ANSI 61 SECTION 5-Certified to NSF/ANSI 61

Material for use in contact with drinking water only (Cold 23°C).

Primus Line Water Low Pressure System:

DN150-LP
DN150SD-LP
DN200-LP
DN203SD-LP
DN250-LP
DN261SD-LP
DN300-LP
DN350-LP
DN400-LP
DN450-LP
DN500-LP

Primus Line Water Medium Pressure System:

DN150-MP

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Hygiene-Institut des Ruhrgebiets
Institut für Umwelthygiene und Toxikologie
Direktor: Prof. Dr. rer. nat. I. Dunemann
Träger: Verein zur Bekämpfung der Volkskrankheiten im Ruhrkohlengebiet e.V.

Rädlinger Primus Line GmbH
Kammerdorfer Straße 16
93413 CHAM

TEST CERTIFICATE
according to the KTW-Guideline

Product: Primus Line Type G

Test specimen: Pipe segments made of inner hose, intermediate layer and outer hose

The test specimen meet the requirements according to the test report no.: K-270164-16-Ko, K-270166-16-Ko and K-270167-16-Ko dated 17.05.2016 for the following applications and temperatures, as far as technically suited:

Applications	cold water (23°C)	warm water (60°C)	hot water (95°C)
Pipes with DN < 80 mm (domestic distribution)	---	---	---
Pipes of diameter 80 mm ≤ DN < 300 mm (supply pipes)	passed	---	---
Pipes of diameter DN ≥ 300 mm (main pipes)	passed	---	---
Fittings for pipes with DN < 80 mm	passed	---	---
Fittings for pipes with 80 mm ≤ DN < 300 mm	passed	---	---
Fittings for pipes with DN ≥ 300 mm	passed	---	---
Sealings for pipes with DN < 80 mm	passed	---	---
Sealings for pipes with 80 mm ≤ DN < 300 mm	passed	---	---
Sealings for pipes with DN ≥ 300 mm	passed	---	---
Tanks in domestic installations including repair systems	passed	---	---
Tanks other than in domestic installations including repair systems	passed	---	---

If pipes, sealings or fittings and ancillaries do not differ in their material composition and process of manufacture, testing of the smallest diameter of the product range is sufficient.

This test certificate is valid beginning with the date of issue and is ending by 17.05.2021 as far as there are no changes in the formula. After this time it can be extended for further 5 years if demanded.

The Director of the Hygiene-Institute
on behalf of

Dr. rer. nat. Andreas Koch
Head of the Dept. for water hygienic, material testing

DAkkS Deutsche Akkreditierungsstelle D-PL-13043-02-00

Hygiene-Institut des Ruhrgebiets
Institut für Umwelthygiene und Toxikologie
Direktor: Prof. Dr. rer. nat. I. Dunemann
Träger: Verein zur Bekämpfung der Volkskrankheiten im Ruhrkohlengebiet e.V.

Rädlinger Primus Line GmbH
Kammerdorfer Straße 16
93413 Cham

TEST CERTIFICATE

Enhancement of Microbial Growth on Materials to Come into Contact with Drinking water
Test pursuant to DVGW Technical Standard W 270, November 2007

Client: Rädlinger Primus Line GmbH
Kammerdorfer Straße 16
93413 Cham

Test material: **Primus Line Type G**

Test method: Material test

According to test report **W-273905e-16-SI/Krü** of **02.08.2016**, the hose-material **Primus Line Type G** is conform to the requirements for the use in the area of drinking water systems pursuant to DVGW Technical Standard W 270. Details regarding testing procedure and test results are itemized in the test report.
This test certificate is valid from the date of issue and, given that the conditions and requirements remain unaltered, expires on **02.08.2021**. Upon request of the client, the validity may be extended up to another 5 year term provided that the specifications of Technical Standard W 270 are met.

The Director of the Institute
p.p.

Dr. Chr. Schell
Head of Laboratory
Department of Water Hygiene and Environmental Microbiology

DAkkS Deutsche Akkreditierungsstelle D-PL-13043-02-00

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PRIMUS LINE
The prime solution for pipes.

5.3 Host Pipe Material

The Primus Line® system can be installed regardless of the host pipe material and is suitable for, including, but not limited to, asbestos cement, concrete, ductile iron, cast iron, PVC, HDPE, and steel. The host pipe has to be able to accommodate all external loading. Internal pressures are completely accommodated by the Primus Line® system. Since the liner works independently from the host pipe with respect to the internal pressure, it can bridge pinholes and gaps. In case of protruding soil, it is recommended to close these areas, for example with patch liners. Protruding ground water will accumulate in the annular space and does not get in contact with the transported fluid since the liner is terminated with the end fittings.

5.4 Annular Space

5.4.1 Host Pipe laid straigt

The annular space defined as the void between the inner diameter of the host pipe and the outer diameter of the Primus Liner has to be equal to or greater than 1 mm (approx. 0.04 inches) when verifying the continuously free inner diameter of the host pipe with the Primus Line product portfolio.

5.4.2 Host Pipe laid with bends

The annular space defined as the void between the inner diameter of the host pipe and the outer diameter of the Primus Liner has to be equal to or greater than 8 mm (approx. 0.31 inches) when verifying the continuously free inner diameter of the host pipe with the Primus Line product portfolio.

A reduction of the hydraulic capacity with the Primus Line® system is also feasible by installing a smaller diameter into an existing larger diameter host pipe.

5.5 Operating Conditions

5.5.1 Operating Pressure

The Primus Line® system requires a minimum operating pressure of 0.5 bar (approx. 7.3 psi) to achieve its full round shape. The system can be designed to accommodate lower sectional operating pressures by installing, for example a siphon so that the liner is continuously filled with the transported fluid. The pressure rating of the Primus Line® system according to the **Product Portfolio** is based on the burst pressure of the system. Long term tests according to ISO 9080 have derived a fabric factor of 2.0 to realise a minimum life span of 50 years. An additional safety factor of 1.25 for water applications and 2.0 for oil and gas applications has been considered.

5.5.2 Different Load Types

Cyclic Loads

The Gas Technology Institute (GTI) based in Des Plaines, IL, United States performed tests on behalf of the US Department of Transportation (DOT) to assess the performance of the Primus Line® system under cyclic pressures.

For the long-term pressure rating, the American Petroleum Institute (API) Recommended Practice 15S for the qualification of spoolable reinforced plastic pipes determines the pressure rating of composite products from a series of stress rupture tests under constant pressures at room temperature and elevated temperature respectively. Based on ASTM D2992 creep failure points are determined from samples failing at durations ranging from 100 hours to 10,000 hours when subject to various constant hydrostatic pressures.

The report shows the effect of cyclic loads on the longevity of the Primus Line® system. The report concludes that the long-term cyclic pressure of the system was about 50% (de-rating factor of 2.0) of the short-term burst strength at about 315,000 cycles at room temperature.

The detailed test report can be accessed via the following link:

Test Report

https://primis.phmsa.dot.gov/matrix/FilGet.rdm?fil=10312&s=EEE58739AE38478EB-118D958E1C3C537&c=1

Collapse Resistance

Primus Line® is considered a flexible liner and has only minimal inherent ring stiffness. The lining material will not fold onto itself, if it is without pressure as per the picture below. In case of external pressure due to a water column, the internal operating pressure needs to be greater to maintain the liner's round shape. If the internal pressure is lower than the external pressure and is not filled with the transported fluid, the liner can be flattened by an external water column. Once the liner is repressurized and exceeds the external pressure, it is returned into its round shape. Water in the annular space can be evacuated through monitoring pipes at the host pipe or by loosening the connector from the flange at the host pipe.

Negative Pressure

The Primus Liner is considered a flexible liner that is installed loose-fit and does not adhere to the host pipe material. The liner is flexible and has only minimal inherent ring stiffness. In case of negative pressure, the liner will be contracted, however turns back into its full round shape with the application of pressure. A test was conducted comparing a virgin sample to a treated sample. The treated sample was exposed to -0.8 bar (approx. -11.6 psi) of negative pressure for ten minutes and subsequently a positive pressure of 10 bar (approx. 145 psi) was applied for another ten minutes. This cycle was repeated for six times. A subsequent burst pressure was conducted on the virgin sample and treated sample. There was no significant difference in the burst pressure.

In general, frequent exposure to negative pressure shall be avoided. In case of sewer rising mains which work intermittently, back flow prevention valves can be installed so that negative pressure is avoided and the liner is continuously filled with the transported fluid.

5.6 Electrostatics

Electrostatics in pipelines that are transporting gaseous fluids can pose a hazard. GICON, an independent engineering firm was tasked by a natural gas network operator to review the explosion hazard during the operation of a flexible high-pressure liner in natural gas networks.

The report concludes that there is no risk for any hazardous discharge as there is the possibility for charge compensation in the host pipe.

5.7 Operating Temperature

The maximum operating temperature for the Primus Line® system must not exceed 50 °C (122 °F).

5.8 Flow Characteristics

- the flow rate must not exceed 3 m/s (approx. 9.8 feet/s)
- a free intake or free outflow has to be avoided
- the roughness of the Primus Line® system has been determined by an external institute with k = 0.028 mm (approx. 0.0011 inch)
- the c-Factor of the Primus Line® system has been internally calculated and has a value of 145 - 150 in the permitted area of application

5.9 Permeation

The physical phenomenon of permeation does occur for all existing plastic types; only the degree of permeation is different. Therefore the Primus Line® is applied with the TPU inside coating. Its outstanding permeability resistance is superior in contrast to many other plastic types.

The limited value for the TPU inside coating, based on realistic and achievable values, was fixed in tests with Primus Line® by the DVGW. Furthermore the testing basis VP643 orders, that the permeation of the outside coating has to be at least the decuple of the inside coating. The outside coating has to be more permeable than the inside coating to avoid an accumulation in the fabric layer, which leads to a separation of the outside coating. The limited values are determined in annual tests in compliance with DIN 53536, which regulates the standard conditions with methane as test gas as follows:

determined average permeability coefficient of methane gas inner layer of Primus Line®	0.03 $cm^3 \times m^{-2} \times h^{-1}$
superior acceptance criteria	0.5 $cm^3 \times m^{-2} \times h^{-1}$
determined permeability coefficient of methane gas outer layer of Primus Line®	20.62 $cm^3 \times m^{-2} \times h^{-1}$
lower acceptance criteria	5.0 $cm^3 \times m^{-2} \times h^{-1}$

Example:

The permeability coefficient of methane gas for Primus Line® is specified with 0.03 $cm^3 \times m^{-2} \times h^{-1}$. Consequently the permeability is 0.032 ml/h for 1 meter Primus Line DN 400 with an operating pressure of 1 bar. Thus the permeability will be 0.8 ml/h if you work with an operating pressure of 25 bar.

5.10 Special Applications

Multiple Liner Solutions

The Primus Line® system can be used to install multiple liners into an existing host pipe. The existing host pipe functions as a conduit and the installed liners can be used to transport different fluids. The liners can accommodate the entire internal pressures independently from the host pipe. Special connectors can be designed for this type of application by the manufacturer.

Reduction of the Hydraulic Capacity

The Primus Line® system can be used to improve the flow properties and quality of the transported fluid by installing a smaller diameter Primus Liner into an existing host pipe. Rededication of existing infrastructure abandoned pipes can be revitalised by installing a Primus Line® system since the system is independent from the host pipe material. Hygienic certifications are available to turn existing pipework into potable water lines.

Double Containment

In case of hazardous liquids or pipelines with a high consequence of failure, the Primus Line® system can be used to provide a second barrier. The pipe-in-pipe approach provides additional safety for the transport of hazardous fluids and the integrity of the installed Primus Line® system can be monitored.

Upgrading Existing Pipework

With increasing demand, higher pressure ratings on existing pipework might be required. Since the Primus Line® system accommodates the pressure rating independently from the host pipe material, a liner with a corresponding pressure rating can be installed to increase the pressure on existing infrastructure.

Emergency Bypass

In case of a breakdown of critical pipe infrastructure, the Primus Line® system can be deployed as an emergency bypass to continue the supply of potable water to affected residents. The liner can be placed on the ground and the damaged pipe network can be bridged. Due to the reinforcement, the complete operating pressure is accommodated.

Installation through Bends

The Primus Liner can be inserted through multiple bends of up to 45° with a radius equal or greater than 1.5xD. The maximum continuous operating pressure is reduced in the most significant bend. The pressure reduction for certain projects can be determined with the table in chapter 4.1.1.2.

6. Installation Process

6.1 Access to the Old Pipeline

6.1.1 Pits

Pits are required at the beginning and the end of each rehabilitation section. Pits in between have to be established with the same dimensions.

Key pit details:

- clear workspace of 40 cm (approx. 15.8 inches) underneath the pipe.
- clear workspace of 60 cm (approx. 23.6 inches) on either side of the pipe.
- pipe to be rehabilitated to protrude from the pit wall by not less than 60 cm (approx. 23.6 inches)

The pipe section to be removed inside the pit has to be at least 1.25 m (approx. 4.1 feet) and up to max. 2.75 m (approx. 9 feet) (required workspace) long. The length varies with the system diameter and the number of connectors to be installed (one connector in each pit at starting and end pits, two connectors in intermediate pits). The pits have to be built in compliance with the generally acknowledged and valid codes of technical practice. It is subject to the mandatory industrial accident prevention codes and regulations of construction associations as well as the local standards and safety codes.

6.1.2 Distribution and Valve Pits

The manhole represents either the starting point (inserting the liner) or an intermediate point (pulling the liner through). A manhole at the end pit (pulling the liner out) is generally inconvenient. The liner should be pulled out with the lowest possible angle. The manhole should be replaced with a pit. Additional civil works like core holes or breaking down some of the manhole may be used to prepare the manhole at the end for pulling out the liner. Access to the manhole must be large enough to feed-through the connector flange.

Key details for working inside the manhole:

- clear workspace of 40 cm (approx. 15.8 inches) underneath the pipe.
- clear workspace of 60 cm (approx. 23.6 inches) on either side of the pipe.
- pipe to be rehabilitated to protrude from the manhole wall by not less than 60 cm (approx. 23.6 inches)

In order to create workspace, the old pipe can also be cut off directly at the manhole wall. In that case, the connector will be attached to a plate on the outer sleeve and screwed to the manhole wall.

The pipe section to be removed inside the manhole has to be at least 1.25 m (approx. 4.1 feet) and up to max. 2.75 m (approx. 9 feet) (required workspace) long. The length varies with the system diameter and the number of connectors to be installed (one connector in each manhole at starting and end points, two connectors in intermediate manholes).

Working in the manholes must comply with the generally acknowledged and valid codes of technical practice. All work is subject to the mandatory industrial accident prevention codes and regulations of construction associations as well as the local standards and safety codes.

6.1.3 Pump Rooms

The procedure for pump rooms is equivalent to that of section 6.1.2.

6.2 Cutting the Pipe

The pipes in pits, manholes and rooms are to be cut to a length of at least 1.25 m (approx. 4.1 feet) and not more than 2.75 m (approx. 9 feet) (required workspace). The length varies with the system diameter and the number of connectors to be installed (one connector in each manhole at starting and end points, two connectors in intermediate manholes).

Each pipe cut must be made perpendicular to the pipe axis. It has to be deburred and chamfered at the inner diameter of the host pipe. At each of the cut-off points, both the inner and outer diameter of the pipe have to be measured and documented. The pipe material must be described and documented as well.

6.3 Camera Inspection of Old Pipe Prior to Cleaning

The entire pipe length has to be inspected prior to cleaning the old pipe and inserting the liner. The camera inspection will be recorded and the recording submitted to the customer at the end of the project.

At each of the cut-off points, both the inner and outer diameter of the pipe have to be measured and documented. The pipe material must be described and documented. Both camera inspection and recording/validation will focus on the following points:

- reductions in cross sections caused by incrustations and obstacles protruding into the cross section (sagging weld seam roots, protruding flanges, screws, pins, plugs, fittings or sacrificial anodes).
- sudden changes in cross section (steps)
- direction changes (bends)

Camera inspection results will be taken as the basis of planning how to clean the pipe. Ideally, the project setup includes a camera inspection of the pipe section to be handled already. Apart from inspecting the pipe, the camera will be used to establish a rope connection between the pits.

6.4 Cleaning the Pipe

The goal of the rough cleaning is to provide a free inner diameter of the pipe. Therefor high water pressure cleaning techniques are used. Spring steel scrapers and rubber discs have also shown their support in the rough cleaning process. Pigs can also be sufficient to clean non-metal pipes and pipes with a non-metal internal coating (not including subsequent cement mortar coatings). Stationary obstacles (casting defects, sagging weld seam roots, protruding flanges, screws, pins, plugs, fittings or sacrificial anodes, etc.) protruding from the pipe wall will be removed by removing the pipe section containing the obstacle or by using a milling robot equipped with diamond tools. Weld seams have to be machined until they are perfectly uniform and flat all the way around.

6.5 Camera Inspection of Old Pipe After Cleaning

The entire pipe length has to be reinspected after cleaning and before inserting the liner. The camera inspection will be recorded and the recording submitted to the customer at the end of the project. Both camera inspection and recording/validation will focus on the following points:

- cross section after cleaning: free from reductions in cross section caused by incrustations and obstacles protruding into the cross section (sagging weld seam roots, protruding flanges, screws, pins, plugs, fittings or sacrificial anodes).
- maximum cross-sectional jumps or maximum mismatch of pipe joints: At and near a cross-sectional jump, the minimum width to be obtained is the outside diameter of the fitted liner.
- direction changes (bends): detection of the bend radius; the bend to negotiate must have a minimum radius of not less than 1.5xD. Liner installation and subsequent application of operating pressure supports a maximum of 45° bends.

6.6 Inserting of the Liner

The liner is folded by the manufacturer and its U-shape is maintained by adhesive tape. The U-shaped and folded liner is spooled onto transport reels (max. outside diameter: 2.5 m (approx. 8.2 feet), drum shaft diameter: 1 m (approx. 3.3 feet) and placed at the starting pit of the section. Depending on the reel weight and length, either unwinding rails or unwinding stations are used to unwind the liner from the reels.

A winch is placed at the destination pit of the pipe section. From there, the rope of the winch is pulled through the pipe to the pit at the starting point. Depending on the liner diameter, the length of liner to be inserted and the bends in the section, either a rope or a pulling head is attached to insert the liner. The rope or pulling head is connected to the rope of the winch.

To prevent the liner from twisting while being inserted, an anti-twist device is installed between the rope (or pulling head) and the rope of the winch. On straight sections, the liner can be inserted with speeds of up to 10 m (approx. 32.8 feet) per minute. When going through bends, the insertion speed is to be reduced to not more than 5 m (approx. 16.4 feet) per minute. Inserting the liner is complete when at least 3 m (approx. 9.8 feet) of tensionless liner after the rope or pulling head come to rest in the destination pit.

6.8 Installing the Connectors

A two-piece design of connector is used. The liner is mechanically jammed-in between an outer sleeve and a connector core. The outer sleeve is fitted with a flange and is screwed to the flange of the old pipe. The outer sleeve may also be welded to the old pipe if the old pipe is made of weldable steel. After attaching the outer sleeve, the liner is cut directly at the edge of the sleeve. Either a flange or a welding end is attached to the connector core which is inserted in the liner or the outer sleeve. Like this, the adapter (i.e. the link between the rehabilitated section and the adjoining pipe) can be screwed or welded to the connector core. The connectors provide a permanently sealed connection between the rehabilitated pipe section and the adjoining pipe section.

6.7 Inflating the Liner by Means of Compressed Air

In order to inflate the liner or to give it its final round shape, sealing balloons are used to close the beginning (pit 1) and end (pit 2) of the liner. One of the sealing balloons features a bypass. Oil-free compressed air has to be blown into the bypass and from there into the liner. At an internal pressure of 0.5 bar (approx. 7.3 psi) or higher, the adhesive tapes (maintaining the U-shape) begin to break. All of the tapes will have opened at a maximum internal liner pressure of 1 bar (approx. 14.5 psi). After inflating the liner, the liner can be cut to a length of 1 m (approx. 3.3 feet) projecting the old pipe in both the starting and destination pits. The 1 m (approx. 3.3 feet) of projecting end of liner is required to install the connectors.

6.9 Pressure or Leak Test

To perform the pressure or leak test, a blind flange is used to close the flange at the connector core. Another option is to use a dished boiler end to close the welding end of the connector core. The connectors need to be safeguarded with reference to the horizontal forces resulting from the test pressure that the sample was exposed to. Any known method of leak-testing metal and non-metal pipes may be used to test the liner.

Water liners and oil liners are tested by using potable water.
Gas liners are tested by using compressed air.

7. References

Primus Line has grown tremendously since its foundation. Several hundred kilometres/miles of liner have been installed for 200 satisfied customers in more than 25 countries around the globe. Several of these rehabilitated pipes have been renewed with the Primus Line® system more than 15 years ago and are still going strong for at least another 40 years of service.

At its core Primus Line® is a technology for the rehabilitation of old pipelines carrying varied types of water, gas or oil. But as a result of its unique properties the system is capable of a much wider variety of applications.

In Lismore, Australia Primus Line® not only renewed a failing water main but at the same time upgraded its pressure rating from 9 bar to 16 bar (approx. 131 psi to 232 psi). The strong, self-supporting structure of the Primus Liner does not just allow for such upgrades but also for its use outside of a host pipe. In Messina an emergency bypass with three DN 300 (12 inches) liners – laid above-ground along a hillside – restored the city's water supply in just a few days after a landslide had damaged a DN 1000 (40 inches) steel water pipeline. The compact Primus Line transport reels help immensely in bringing liners to such hard to access places. While in Messina a chain dredger brought the reels up the steep climb, in Spain they actually were flown to a mountain by helicopter. These reels are available in different sizes up to a length of 11 m (approx. 36 feet) and can hold 5,300 m (approx. 17,300 feet) of liner at once, significantly reducing transport costs.

In some cases not the location but the pipeline itself is hard to access or runs in a particularly complex way. The Primus Liner is very flexible and can easily negotiate bends of up to 45° within a pipe as well as obstacles outside a pipe. For projects in Norway, Spain and the USA the liner was first inserted through existing inspection pits before being pulled through the host pipe, completely foregoing any earthworks. In a majority of cases earthworks are still unavoidable even for trenchless technologies. Primus Line® requires only few construction pits with a very small footprint, minimising the environmental impact of a pipeline rehabilitation. Traffic in densely packed urban areas like Brussels went on unhindered, and protected, decade-old olive groves in Turkey were preserved while ageing pipelines got an extended service life.

Conducive to the overall small footprint is a reduced machine employment. Combined with insertion lengths of 2,500 m (approx. 8,200 feet) in one pull that makes Primus Line® an excellent solution for rehabilitating underwater pipelines. After the renewal with the system, a diesel pipeline in the southern Mediterranean Sea is now well protected both from salt water on the outside and the diesel flowing through due to the Primus Liner's high resistance to various types of corrosion. In collaboration with Anticorrosion Protective Systems and Petronas, Primus Line has also developed the InField Liner, a product even better adapted to the requirements of highly corrosive hydrocarbons found in media such as oil.

Primus Line® is a highly versatile system for a wide range of applications that keeps growing constantly – not least due to customised designs developed for specific customer needs.

For additional references, please refer to our "Projects" tab in the Media Center:

https://www.primusline.com/primus-line/#media-center

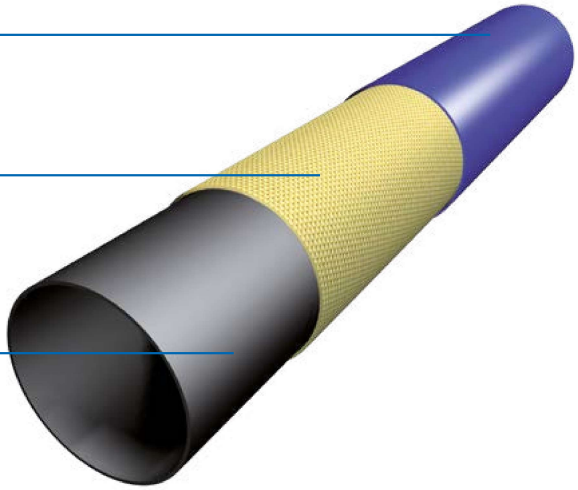
Attachments

CHEMICAL RESISTANCE - SYSTEM PRIMUS LINE®

The system Primus Line® consists of hose and connector. The inner layer of the liner as well as the connector coating are the layers which are in direct contact with the transported media.

Primus Line Hose

Type: Low, Medium and High pressure



Outer Layer:
- Polyethylene (PE)

Fabric:
- Low Pressure: Aramid + Polyester
- Medium and High pressure: Aramid

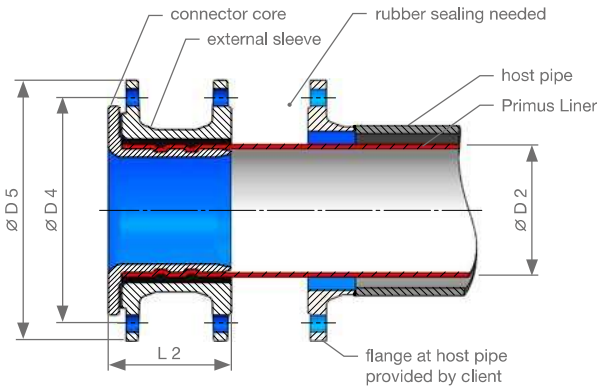
Inner Layer: Media specific based on polyethylene (PE) or thermoplastic polyurethane (TPU)
- PE Water
- TPU Gas
- TPU Oil (applicable for aliphatic hydrocarbons and aqueous solutions)

Primus Line Connector

Type: Low, Medium and High pressure

Type 1: Low Pressure Connector with two flanges

field of application	water
connector+flange	made from cast iron or carbon steel
flange compatible with	EN 1092
coating	Resicoat



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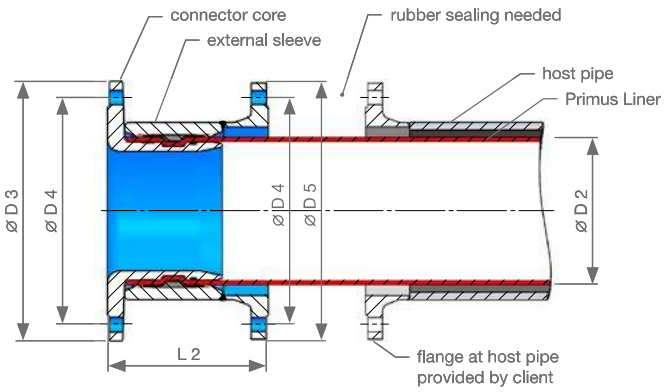
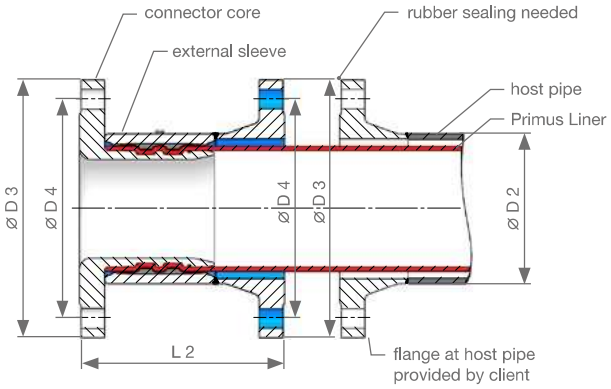
Type 2: Medium Pressure Connetor with two flanges

field of application	water / oil
connector+flange	made from cast iron or carbon steel
flange compatible with	EN 1092
coating	Resicoat



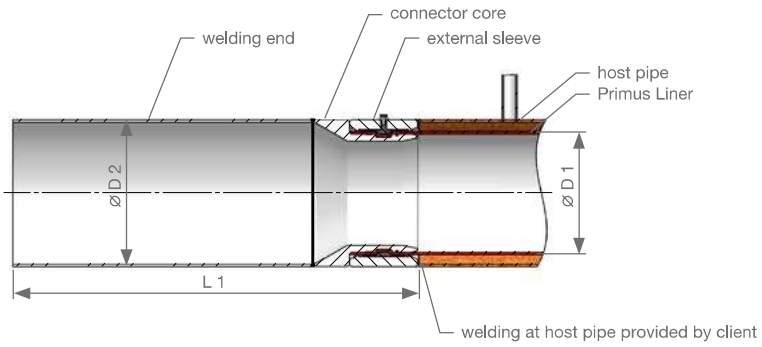
Type 3: High Pressure Connetor with two flanges

field of application	water / oil
connector+flange	made from carbon steel and stainless steel (1.4462)
flange compatible with	EN 1092
coating (external sleeve)	Resicoat



Type 4: Medium and High Pressure Connetor with welding end

field of application	gas
connector+flange	made from carbon steel
coating	without



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The information given in the following tables 1-3 is based on immersion tests without mechanical stress and corresponds to the current level of knowledge and experience.

Additional parameters like higher concentrations and temperatures and in particular the mixture of different media, leads to new assessment criteria.

Unless specified in the standard, the tests were carried out using internal methods on in-house testing equipment. Tests using other methods or on other test equipment would produce different results.

As a result of our ongoing development work, we reserve the right to modify products and change the features of the products. The information, recommendations and suggestions provided in this document cannot be used to derive any legally binding assurance or warranty for certain properties or the suitable of the product for a specific application.

The information regarding the chemical resistance refers to an operation temperature of 20°C.

Table 1	
field of application: water	Inner layer PE
Medium	
Drinking water	resistant
Supply water	resistant
Process water	resistant
Treated waste water	resistant
Industrial waste water	examination technical department
Seawater	resistant
Saturated brine	resistant
Chlorine water (2.5ppm chlorine)	resistant

Table 2	
field of application: oil	Inner layer TPU
Medium	
Diesel	resistant
Kerosine	resistant
Heavy oil	resistant
Avgas	resistant
Hydraulic oil	resistant
Crude oil	examination technical department
Heating oil	examination technical department
Mogas	not resistant
Biodiesel	not resistant
Wide Light Hydrocarbon Fraction	examination technical department
Gasoil	examination technical department
Pygas	not resistant
Chlorine water (1.5ppm chlorine)	resistant

Including also media analogous table 1

Including also media analogous table 3
(Exception: hydrolysis resistance of Primus Line® Oil)

Status 12/2015

Table 3	
field of application: gas	Inner layer TPU
Medium	
Natural gas	resistant
Coke oven gas	resistant
Methane	resistant
Propane	resistant
Butane	resistant
Hydrogen	resistant
Nitrogen	examination technical department
Carbon dioxide	resistant
Carbon monoxide	resistant
Oxygen	resistant
Hydrogen sulphide	not resistant
Biogas	not resistant

Not listed media require an additional request. Status 12/2015

Contacts

Raedlinger Primus Line Inc., USA, Canada, Mexico

Executive Vice President Raedlinger Primus Line, Inc.
Andreas Fleischmann
Phone: +49 9971 8088-1110
Mobile: +49 160 905 683 17
Mobile (USA): +1 704 733 0065
andreas.fleischmann@primusline.com

Director of Sales USA
John Moody
Mobile: +1 704 569 4460
john.moody@primusline.com

Area Sales Manager West Coast
Ryley Nelson
Mobile: +1 602 517 8007
ryley.nelson@primusline.com

Area Sales Manager North East
Noel Shanahan
Mobile: +1 602 517 8360
noel.shanahan@primusline.com

Area Sales Manager Mexico
Victor Mackissack
Mobile: +1 704 907 0118
victor.mackissack@primusline.com

Raedlinger Primus Line CA Inc.

Area Sales Manager Canada
Alois Multerer
Mobile (Canada): +1 980 365 9058
Mobile: +49 175 426 5926
alois.multerer@primusline.com

Rädlinger primus line GmbH, Oil & Gas

Business Development Manager Oil & Gas
Håvard Høydalsvik
Mobile: +49 170 914 4315
havard.hoydalsvik@primusline.com

Rädlinger primus line GmbH, International

Head of International Business Development
Andreas Gross
Phone: +49 9971 8088-1101
Mobile: +49 151 649 147 76
andreas.gross@primusline.com

Account Manager International
Peter Lorenz
Phone: +49 9971 8088-1103
Mobile: +49 160 95 31 37 81
peter.lorenz@primusline.com

Account Manager International (CIS)
Robert Henich
Phone: +49 9122 631 8315
Mobile: +49 151 584 924 35
robert.henich@primusline.com

Account Manager International
Sener Polat
Mobile: +49 151 670 063 37
Mobile (Turkey): +90 536 962 4919
sener.polat@primusline.com

Directeur France
Philippe Ferrer
Mobile: +33 (0) 6 79 70 13 44
philippe.ferrer@primusline.com

Area Sales Manager Latin America
Bruno Breder
Phone: +55 21 99887 1901
bruno.breder@primusline.com

Business Development Manager China
Robert Swift
Phone: +852-35 25 17 27
robert.swift@primusline.com

Raedlinger Primus Line Pty Ltd.

Director A-NZ
Heiko Manzke
Phone: +61 490 365 846
heiko.manzke@primusline.com

www.primusline.com

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The prime solution for pipes.