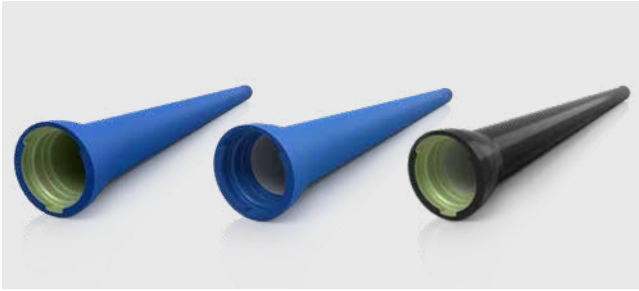
HYDRO

DUCTILE CAST-IRON PIPE SYSTEMS

Technical handbook for drinking water



DUKTUS KEULA ALTECNO

ZEROWATERLOSS

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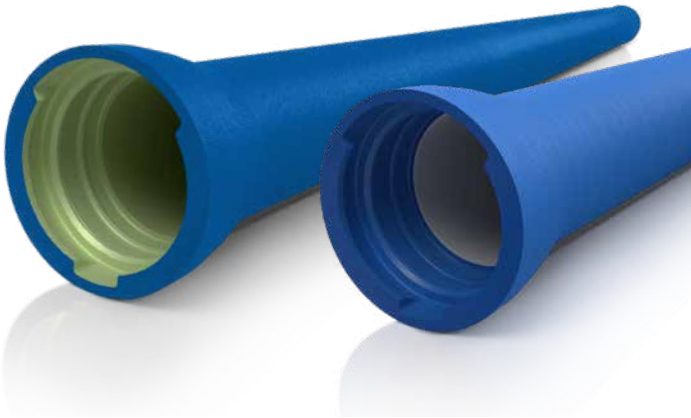
HYDRO
ZEROWATERLOSS

Last updated 01.01.2025

Our new handbook reflects the range of ductile drinking water pipes, fittings and reference valves. All previous issues are hereby declared invalid. This handbook is intended to provide the engineer responsible for planning, the purchaser and the pipe layer with a comprehensive overview of our product range, installation instructions for pipes and fittings and information on the relevant standards.



You can find your contact partners on our homepage
https://www.vonroll-hydro.world/en/sites-and-companies.html

Scanning this QR code with your smartphone will take you directly to the relevant page.

Building Information Modeling (BIM): You will find our BIM files for your planning software here.
https://www.vonroll-hydro.world/en/bim-building-information-modeling.html

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OVERVIEW

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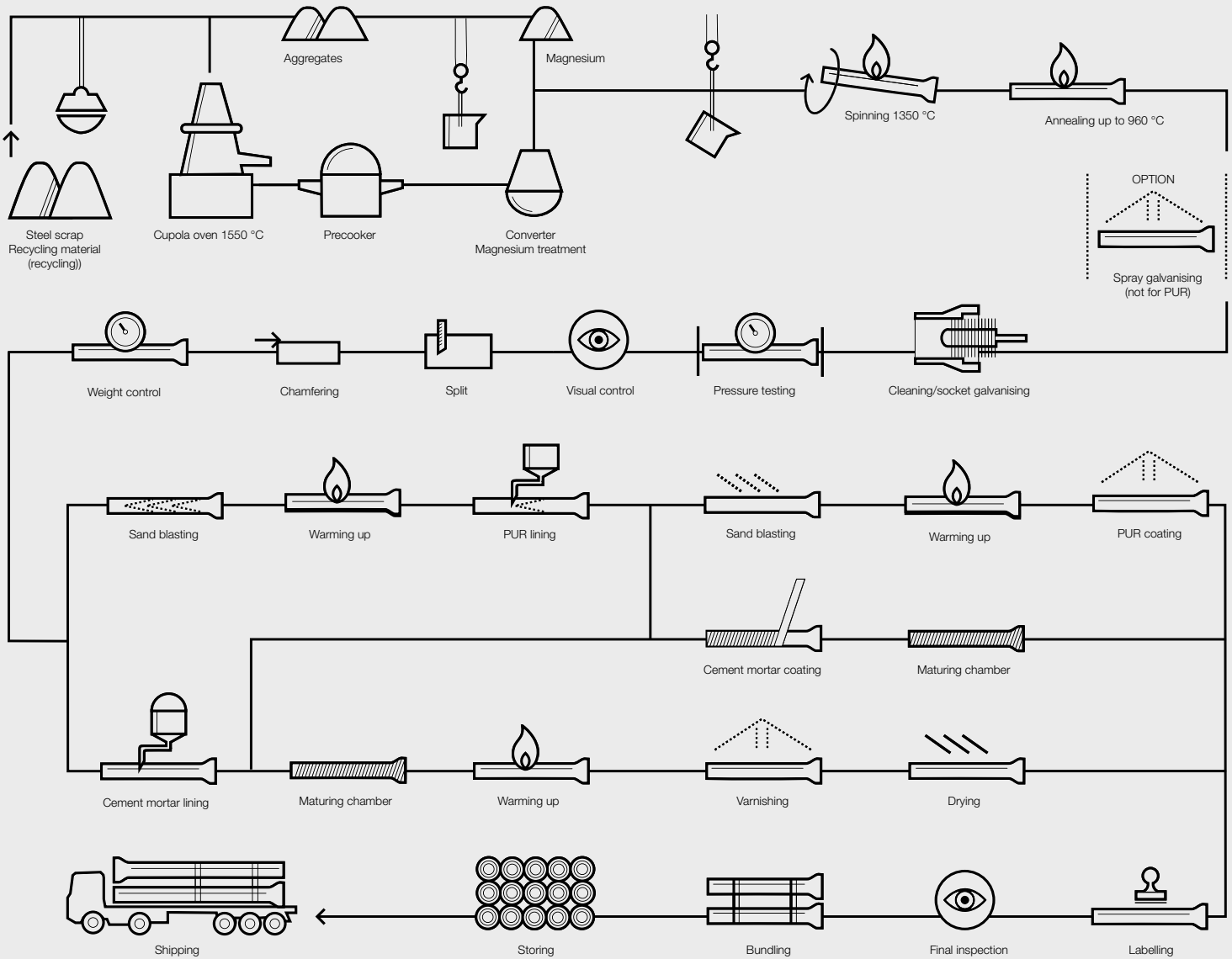
THE WAY TO ZEROWATERLOSS

is the guiding principle of VONROLL HYDRO, with plants in Europe and a worldwide service and sales network. The core element of the strategy is the realisation that water is no longer just readily available in sufficient quantities all over the world, in Europe and even in the 'water castle' that is Switzerland. Population growth and increasing expectations of prosperity are huge consumers of water. Residues from pesticides and fertilisers are polluting the increasingly scarce drinking water resources. Water is a key part of the intergenerational contract. We must build infrastructure today with high-quality, durable components. Water quality and water use must be monitored and assured through innovative products and services (HYDROPORT and INFRAPORT as the foundations of the Smart City). The components required for our infrastructures must be manufactured in the region where possible. This will mean that our values – which are reflected in the occupational safety and environment protection laws, among other areas – are incorporated into our infrastructures. Thanks to short transport distances, CO_2 and exhaust gas pollution are minimised at the same time. With first-class products (VONROLL, DUKTUS, KEULA and ORTOMAT) and services (maintenance, sensor technology, leak detection, alarms, INFRAPORT as a web-based visualisation and integration platform), VONROLL HYDRO is positioning itself as a solution provider in a world that is coming under increasing pressure due to WATERLOSS.

MANUFACTURING PROCESS



CERTIFICATES

The products of VONROLL HYDRO (Germany) gmbh&co kg for supplying drinking water are certified by the German Technical and Scientific Association for Gas and Water (DVGW) and the Swiss Gas and Water Association (SVGW). The technical test specification of the DVGW according to GW 337 serves as the basic for this certification. All of the materials we use in production that come into contact with drinking water during subsequent use, such as the lubricant, the seal, the POLYURETHANE coating and the cement mortar lining (DVGW W 347), have been tested in accordance with the relevant DVGW guidelines or comply with the evaluation criteria of the German Environment Agency (KTW-BWGL – evaluation criteria for plastics and other organic materials in contact with drinking water). This means that a negative impact on drinking water quality due to our products can be ruled out. The manufacture and the production control of our products at the plant are both subject to regular external monitoring.

Our ductile cast-iron pipes and fittings with a longitudinal positive locking BLS push-in socket joint also have FM Approval in nominal sizes DN 80 to DN 400. This means that these pipes and fittings may be used for fire extinguisher systems with this requirements profile.

Our fittings are coated on the inside and outside with an epoxy resin coating in accordance with EN 14 901. This coating also fulfils the strict requirements of the "Quality Assurance Association for Heavy-Duty Corrosion Protection" (GSK). This means that our fittings can be installed in ground of any corrosiveness in accordance with EN 545.

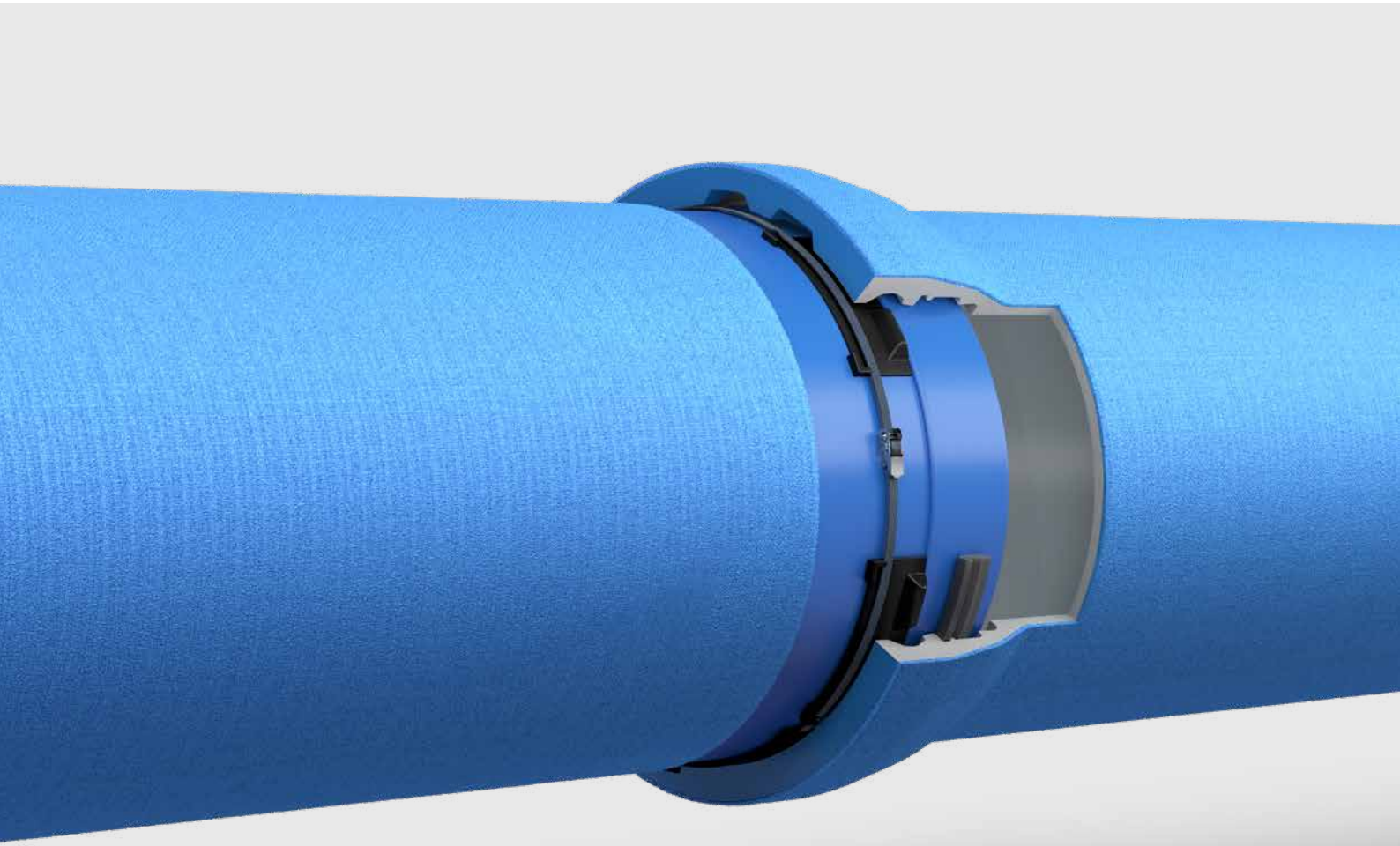
Valves and fittings are provided with an integral epoxy resin powder coating, and can, in addition, optionally be offered with enamelling. The existence of DVGW approval guarantees a high standard of quality for the valves and fittings. A selection of the most important certificates is available for download at **vonroll-hydro.world/Zertifikate** (QR code).

Tender texts in accordance with the current EN 545 for pipes and fittings are available for download at vonroll-hydro.world.

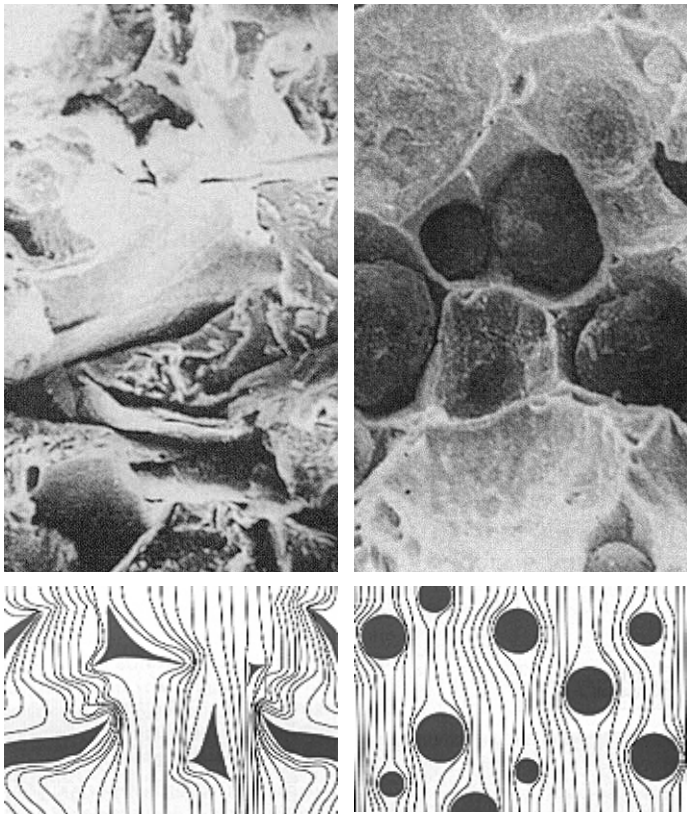
RAL GÜTEZEICHEN Duktile Guss-Rohrsysteme

1

ADVANTAGES OF DUCTILE CAST-IRON PIPE SYSTEMS



THE MATERIAL



Stress curve for cast iron with lamellar graphite (left)
and with spheroidal graphite (right)

Ductile cast iron is a tough iron-carbon material whose carbon content is predominantly present as graphite in free form. It differs from grey cast iron mainly in the form of the graphite particles. Treating the liquid iron with magnesium causes the carbon to crystallise in a largely spherical form during solidification. This results in a considerable increase in strength and ductility compared with grey cast iron. These bodies, known as 'spherulites', only have a minor effect on the properties of the metallic base structure. In the grey cast iron that was previously common, graphite flakes reduced the relatively high strength of the base structure due to their stress concentration.

While the stress lines are intensely focused on the tips of the graphite flakes in the case of cast iron with lamellar graphite, the stress lines flow around the spheroidal graphite almost undisturbed in the case of ductile cast iron. For this reason, ductile cast iron can be deformed under load. Pipes and fittings made of ductile cast iron are structurally considered to be pliable or flexible pipes.

Material characteristic values
A metallic material such as ductile cast iron retains its mechanical properties throughout its service life. Ductile cast-iron pipes are therefore resilient and reliable even after decades have passed. In accordance with EN 545, the tensile strength and elongation at fracture can be tested using test bars. The following table provides an overview of the material characteristic values of ductile cast iron:

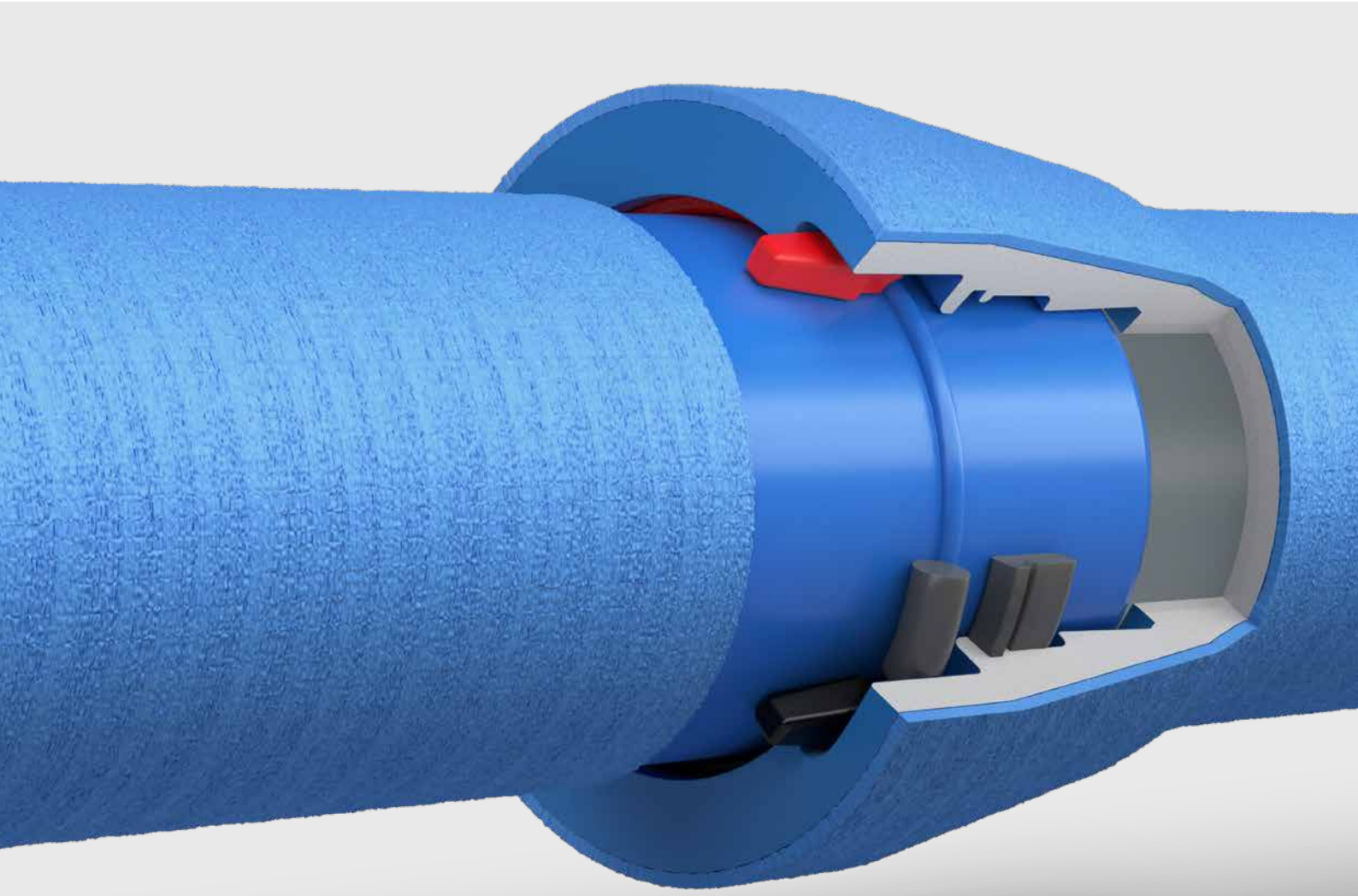
Characteristic values	Unit	Value
Tensile strength	N/mm^2	420
0.2% yield strength	N/mm^2	300
Elongation at fracture	%	≥ 10
Pressure resistance	N/mm^2	900
E-module	N/mm^2	170,000
Bursting strength	N/mm^2	300
Transverse compressive strength	N/mm^2	550
Longitudinal flexural rigidity	N/mm^2	420
Vibration amplitude	N/mm^2	135
Mean thermal expansion coefficient	m/mK	10×10^-6
Thermal conductivity	W/cmK	0.42
Specific heat	J/gK	0.55

HYDRO

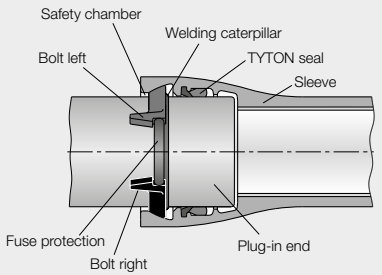
2

BLS
POSITIVE LOCKING SYSTEM TECHNOLOGY

Pipes, fittings and installation instructions



BLS introduction



Example of a positive locking BLS joint

This chapter deals exclusively with longitudinal positive locking push-in socket joints based on positive locking. Positive locking push-in socket joints can always be identified at a weld bead on the spigot end and at a retaining chamber. The positive locking between the weld bead and the retaining chamber is achieved through the insertion of locks or retaining segments. This creates a mechanical force transmission between the spigot end and the socket of the next pipe or fitting.

Forces may arise as a result of internal pressure or external tension. Permissible operating pressures (PFA) and permissible tensile forces are specified on the following pages depending on the nominal diameter. Higher pressures and tension forces can be accommodated in consultation with our Application Technology department.

VONROLL HYDRO offers positive locking BLS push-in socket joints for **pipes, fittings and valves.**

DN 80 to DN 500
Sealing is achieved by means of a TYTON seal. Locking is performed with two to four locks, depending on the nominal size and type of use. It is characterised above all by quick and easy fitting, high permissible operating pressures and tensile forces, and universal applicability. The use of a clamping ring is possible on cut pipes in the nominal size range of DN 80 to DN 500. This usually means that there is no need for a weld bead to be applied on site. For trenchless pipe installation in the nominal size range of DN 80 to DN 250, a high-pressure lock (HPL) is also required. The BLS joint in combination with plastic BLS locks is specially designed for areas under the influence of stray current (e.g. trams, railways, high-voltage overhead lines, etc.) without cathodic corrosion protection. Pipes with a BLS joint in nominal sizes DN 80 to DN 500 are available in installation lengths of 6 m and 5 m. Further information on the BLS joint (DN 80 to DN 500) can be found from page 23 onwards.

DN 600 to DN 1000
The seal used here is also a TYTON seal. Locking is achieved here via 9–14 retaining segments, which are inserted through a socket window and distributed over the circumference of the pipe. Pipes with a BLS joint in nominal sizes DN 600 to DN 1000 are available in installation lengths of 6 m and 5 m. Further information on the BLS joint (DN 600 to DN 1000) can be found from page 28 onwards.

Applications/benefits
Pipes and fittings with BLS joints can be used universally, almost without limitations. With quick and easy installation and high permissible operating pressures and tension forces, they can be used in almost any conceivable application in high-pressure pipeline construction (water or wastewater).

- Municipal water supply
- Replacement of concrete abutments or fixed points for conventional installation in an open trench
- Bridge pipelines/exposed pipes
- Overground pipelines (replacement water supply)
- Trenchless installation procedures (HDD, burst lining, push-pull technique, pipe relining, floating pipe into position, etc.)
- Snowmaking systems
- Turbine pipes
- Installation on a steep slope
- Fire extinguisher pipes (FM Approval)
- Water crossings/culverts
- Building installations
- Use in areas at risk of earthquakes or subsidence

Thanks to the very high deflection capability of up to a maximum of 5° and the ability to rotate through 360°, this joint is also suitable for the formation of demanding and complex node points.

PFA
The permissible operating pressures (PFA) of the BLS joints must be specified in the manufacturer's catalogues in accordance with EN 545 (see the following pages).

PMA = 1.2 × PFA (highest permissible component operating pressure for a short time, e.g. pressure surge).
PEA = 1.2 × PFA + 5 (highest permissible component test pressure on the construction site).

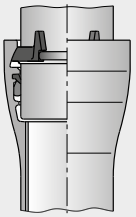
The categorisation into C classes according to EN 545 does not apply to positive locking joints. Accordingly, the minimum wall thicknesses deviate from those in Table 17 of EN 545 (non-longitudinal positive locking pipes). Ductile cast-iron pipes, fittings and valves can be used for negative pressures after consultation with the manufacturer.

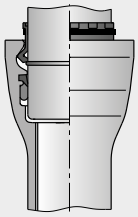
Compatibility
Not compatible with positive locking systems from other manufacturers.

Clamping ring and plastic lock
The use of clamping rings and plastic locks is possible from DN 80 to DN 500 in most cases. For details of the areas of application, see page 25 and the installation instructions from page 58 onwards. The use of clamping rings means that there is no need to subsequently apply weld beads to BLS pipes cut on site.

For possible solutions to this, please contact our Application Technology department at ***support@vonroll-hydro.world***

2.1 BLS JOINTS
Positive locking joints and pipes | Overview

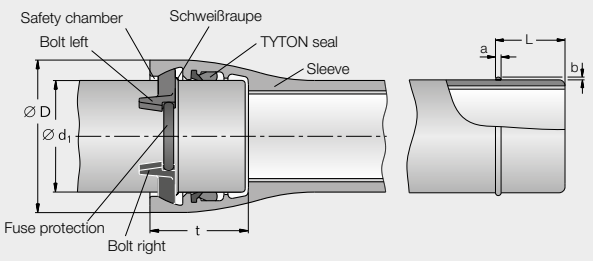

DN 80 – DN 500


DN 600 – DN 1000

DN	PFA[1] [bar]	Perm. tensile strength[3] [kN] ZMU, CEMPUR, ZIPOX, ZIPOX+ DUCPUR	Perm. tensile strength[3] [kN] ECOPUR, ECOCEM	Maximum deflection [°]
80 [2]	100	115	70	5.0
100 [2]	75	150	100	5.0
125 [2]	63	225	140	5.0
150 [2]	63	240	165	5.0
200	42	350	230	4.0
250	40	375	308	4.0
300	40	380	380	4.0
400	30	650	558	3.0
500	30	860	860	3.0
600	32	1525	1200	2.0
700	25	1650	1400	1.5
800	16/25 [2]	1460	–	1.5
900	16/25 [2]	1845	–	1.5
1000	10/25 [2]	1560	–	1.5

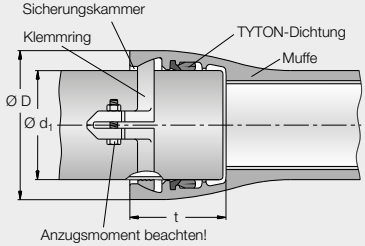
1) PFA: Permissible component operating pressure; PMA = 1.2 × PFA; PEA = 1.2 × PFA + 5 – higher PFA on request
2) Wall-thickness class K10 in accordance with EN 545:2006
3) DN 80 to 250 with HPL – higher tensile forces on request

2.1 BLS JOINTS
DN 80 to DN 500



Notes on the use of BLS
Trenchless installation in DN 80 to DN 250 only with high-pressure lock (HPL)
Higher pressures (snowmaking systems/turbine pipes) possible
Plastic locks (areas under influence of stray current)
Plastic locks are not permitted for trenchless installation procedures.
For installation instructions, see page 58

2.1 BLS JOINT WITH CLAMPING RING
DN 80 to DN 500

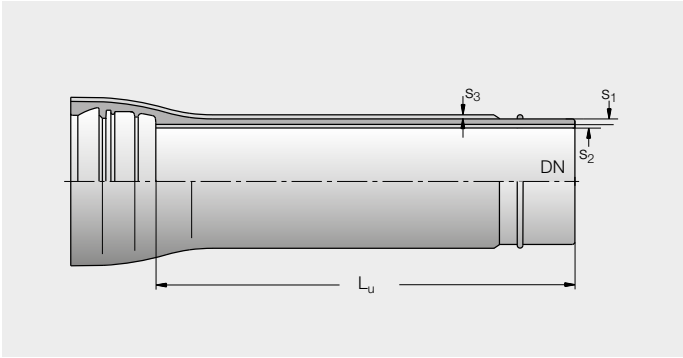


Notes on the use of clamping rings
As a replacement for the weld bead, e.g. on pipes cut on site (MMK, MMQ, MK, EN and ENQ), only up to PFA 16 bar
Not in exposed pipes, not in pulsating pipelines installed in the ground, and not for trenchless installation procedures
Tightening torque 60 Nm
For installation instructions, see page 62

DN	Dimensions [1] [mm]						Weight [kg]				PFA [2] [bar]				Number of locks [3]	Permissible tensile strength [4/5] [kN]	ECOPUR ECOCEM	Maximum deflection [°]	Minimum radius [6] [m]	Fitting time [7] [min]
	d1	D	t	L	a	b	Lock set	HPL	Clamping ring	Seal	Without HPL	With HPL	Clamping ring	Plastic lock						
80	98 + 1/-2.7	156	127	86	8	5	0.4	0.3	0.9	0.13	100	110	45		2	115	70	5	69	5
100	118 + 1/-2.8	182	135	91	8	5	0.4	0.4	1.0	0.16	75	100	45		2	150	100	5	69	5
125	144 + 1/-2.8	206	143	96	8	5	0.6	0.5	1.4	0.19	63	100	45		2	225	140	5	69	5
150	170 + 1/-2.9	239	150	101	8	5	0.8	0.6	1.7	0.22	63	75	45		2	240	165	5	69	5
200	222 + 1/-3.0	293	160	106	9	5.5	1.1	0.8	2.2	0.37	42	63	45	16	2	350	230	4	86	6
250	274 + 1/-3.1	357	165	106	9	5.5	1.5	1.2	2.7	0.48	40	44	45		2	375	308	4	86	7
300	326 + 1/-3.3	410	170	106	9	5.5	2.7	–	3.6	0.67	40	–	30		4	380	380	4	86	8
400	429 + 1/-3.5	521	190	115	10	6	4.4	–	6.0	1.1	30	–	30		4	650	558	3	115	10
500	532 + 1/-3.8	636	200	120	10	6	5.5	–	7.2	1.6	30	–	30		4	860	860	3	115	12

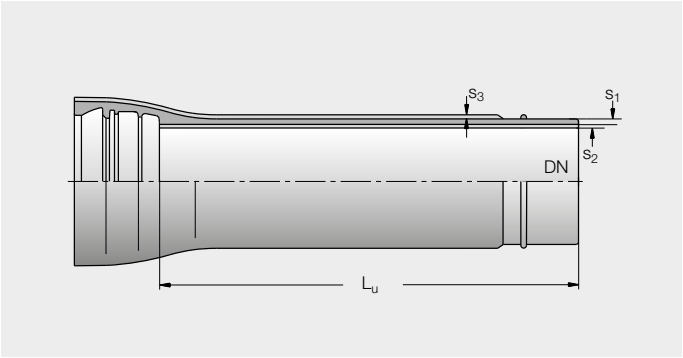
1) Tolerances are possible; 2) PFA: Permissible component operating pressure/PMA = 1.2 × PFA
PEA = 1.2 × PFA + 5 – higher PFA on request – see notes on the use of clamping rings
3) DN 80 to DN 250 plus high-pressure lock (HPL) if necessary
4) Higher tensile forces on request; 5) Permissible tensile force does not apply to clamping ring and plastic lock
6) Minimum curve radius, resulting from the possible deflection of the sockets – applies to open and trenchless installation; 7) Estimated fitting time of the joint without any joint protection

2.2 BLS PIPE
DN 80 to DN 500



External coatings
Zinc coating with cement mortar coating (ZMU, CEMPUR)
Polyurethane (ECOPUR, ECOCEM)
Zinc coating with finishing layer (ZIPOX)
Zinc-aluminium coating with finishing layer (ZIPOX+, DUCPUR)
WKG coating

2.2 BLS PIPE
DN 80 to DN 500



Internal coatings
Polyurethane
Cement mortar lining based on aluminous cement
Cement mortar lining based on blast furnace cement

For notes on coatings, see Chapter 7

DN	Dimensions [4] [mm]			Total weight [kg]					PFA [1] [bar]				pcs. locks [5]	tensile force [7] [6] [kN]	ECOPUR ECOCEM	Max. deflection [°]	Min. radius [8] [m]	Fitting time [10] [min]
	s1 Cast iron	s2 ZMA	s3 ZMU	Pipe [2]	Pipe+ ZMU [3]	ECOPUR pipe [3]	ECOCEM pipe [3]	CEMPUR pipe [3]	Without HPL	With HPL	Clamp ring [9]	Plastic lock						
80	4.7	4	5	96.7	116.2	89.4	100.8	105.0	100	110	45	16	2	115	70	5	69	5
100	4.7	4	5	120.3	144.3	108.0	124.8	127.8	75	100	45	16	2	150	100	5	69	5
125	4.8	4	5	156.4	184.4	138.0	162.0	160.2	63	100	45	16	2	225	140	5	69	5
150	4.7	4	5	192.0	225.0	169.2	198.6	195.6	63	75 1)	45	16	2	240	165	5	69	5
200	4.8	4	5	248.3	291.3	220.2	256.8	255.0	42	63	45	16	2	350	230	4	86	6
250	5.2	4	5	330.3	382.3	293.4	340.8	335.4	40	44	45	16	2	375	308	4	86	7
300	5.6	4	5	424.9	487.9	373.2	437.4	424.2	40	–	30	16	4	380	380	4	86	8
400	6.4	5	5	624.9	706.9	545.4	642.0	611.4	30	–	30	16	4	650	558	3	115	10
500	7.2	5	5	839.9	940.9	740.4	859.8	821.4	30	–	30	16	4	860	860	3	115	12

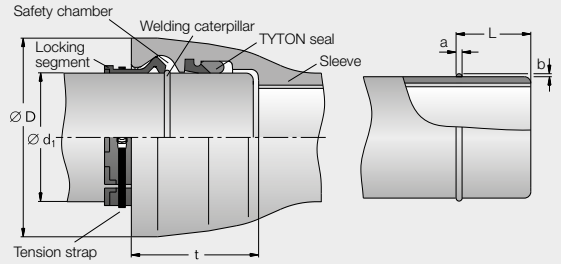
1) PFA: Permissible component operating pressure/ PMA = 1.2 × PFA (PEA = 1.2 × PFA + 5 – higher PFA on request.
2) Theoretical weight per pipe, incl. cement mortar lining, zinc(-aluminium) and finishing layer
3) Theoretical weight per pipe, incl. cement mortar lining, zinc/ cement mortar coating; PUR/PUR; cement mortar lining/PUR; PUR/cement mortar coating
4) s1 = min. dimension, s2/s3/s4 = nominal dimensions. Note tolerances
*** PUR mass, external coating / chapter 3.2 page 91 ff.**

Installation length L = 6 m and 5 m. Special lengths on request

*ZMA Cement mortar lining **ZMU Cement mortar coating

5) DN 80 to DN 250 plus high-pressure lock (HPL) if necessary; 6) Higher tensile forces on request
7) Permissible tensile force does not apply to clamping ring and plastic lock; 8) Minimum curve radius, resulting from the possible deflection of the sockets – applies to open and trenchless installation
9) See notes on the use of clamping rings – page 63 et seq.; 10) Estimated fitting time of the joint without joint protection; 11) smin = 5.0 mm
*** PUR mass, internal coating / chapter 3.2 page 91 ff.**

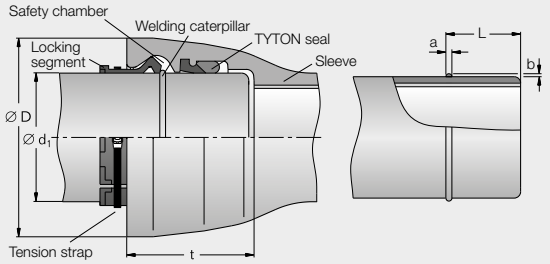
2.2 BLS PIPE
DN 600 to DN 1000



(included in scope of delivery)

Notes on the use of BLS
Trenchless installation only with metal clamps instead of tensioning strap
For installation instructions, see page 68
Higher pressures e.g. for snowmaking systems or turbine pipes possible

2.2 BLS PIPE
DN 600 to DN 1000



(included in scope of delivery)

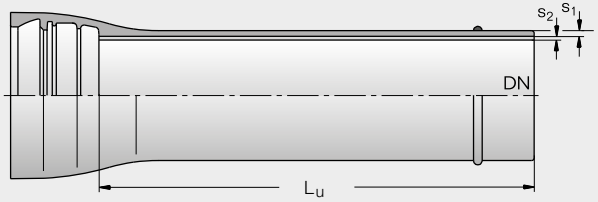
Notes on the use of BLS
Trenchless installation only with metal clamps instead of tensioning strap
For installation instructions, see page 68
Higher pressures e.g. for snowmaking systems or turbine pipes possible

DN	Dimensions [1] [mm]						Weight [kg]		Number of segments	PFA [2] [bar]	Permissible tensile strength [3] [kN]	Maximum deflection [°]	Minimum radius [4] [m]	Fitting time [5] [min]
	d1	D	t	L	a	b	Segment set	Seal						
600	635 +1/-4.0	732	175	116	9	6	9	2.3	9	32	1525	2.0	172	15
700	738 +1/-4.3	849	197	134	9	6	11	4.3	10	25	1650	1.5	230	16
800	842 +1/-4.5	960	209	143	9	6	14	5.2	10	16/25 [6]	1460	1.5	230	17
900	945 +1/-4.8	1073	221	149	9	6	15	6.3	13	16/25 [6]	1845	1.5	230	18
1000	1048 +1/-5,0	1188	233	159	9	6	16	8.3	14	16/25 [6]	1560	1.5	230	20

1) Tolerances possible; 2) PFA: Permissible component operating pressure /PMA = 1.2 × PFA/PEA = 1.2 × PFA + 5
Higher PFA on request; 3) Higher tensile forces on request

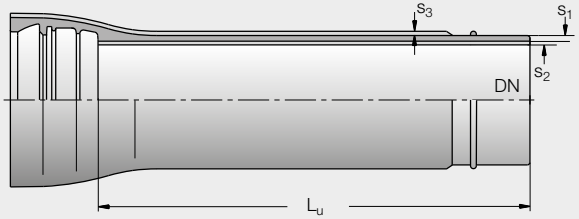
4) Minimum curve radius, resulting from the possible deflection of the sockets – applies to open and trenchless installation; 5) Estimated fitting time of the joint without joint protection
6) Wall-thickness class K10 according to EN 545:2006

2.2 BLS PIPE
DN 600 to DN 1000



External coatings
Zinc coating with cement mortar coating (CEMPUR to DN 700)
Polyurethane (ECOPUR, ECOCEM to DN 700)
Zinc coating with finishing layer (ZIPOX)
Zinc-aluminium coating with finishing layer (DUCPUR to DN 700)
WKG coating

2.2 BLS PIPE
DN 600 to DN 1000



Internal coatings
Polyurethane
Cement mortar lining based on blast furnace cement
Cement mortar lining based on aluminous cement

For notes on coatings, see Chapter 3.2, page 91 ff.

DN	Dimensions [4] [mm]			Weight [kg]					Number of segments	PFA [1] [bar]	Permissible tensile strength [5] [kN]	Maximum deflection [°]	Minimum radius [6] [m]	Fitting time [7] [min]
	s1 Cast iron	s2 ZMA	s3 ZMU	Pipe 6 m [2]	Pipe and ZMU [3]	ECOPUR pipe	ECOCEM pipe	CEMPUR pipe						
600	**8.0**	**5**	**5**	**1118.6**	**1239.6**	970.2	1142.4	1068.0	9	32	1525	2.0	172	15
700	**8.8**	**6**	**5**	**1410.1**	**1550.1**	1237.2	1438.2	1350.6	10	25	1650	1.5	230	16
800	**9.6**	**6**	**5**	**1768.0**	**1928.0**	–	–	–	10	16/25 [8]	1460	1.5	230	17
900	**10.4**	**6**	**5**	**2131.3**	**2310.3**	–	–	–	13	16/25 [8]	1845	1.5	230	18
1000	**11.2**	**6**	**5**	**2524.4**	**2723.4**	–	–	–	14	16/25 [8]	1560	1.5	230	20

1) PFA: Permissible component operating pressure/PMA = 1.2 × PFA/PEA = 1.2 × PFA + 5 – higher PFA on request
2) Theor. weight per pipe, incl. cement mortar lining, zinc(-aluminium) and epoxy resin finishing layer
3) Theor. weight per pipe, incl. cement mortar lining, zinc and cement mortar coating; 4) s1 = min. dimension, s2/s3 = nominal dimensions. Tolerances possible

Installation length "L_u" = 6 m and 5 m. Special lengths on request.

*** PUR mass, external coating / chapter 3.2 page 91 ff.**

5) Higher tensile forces on request; 6) Minimum curve radius, resulting from the possible deflection of the sockets – applies to open and trenchless installation
7) Estimated fitting time of the joint without joint protection
8) Wall-thickness class K10 in accordance with EN 545:2006

*** PUR mass, internal coating / chapter 3.2 page 91 ff.**

2.3 BLS FITTINGS
and valves with positive locking joints
DN 80 to DN 500

Compatibility
Not compatible with positive locking systems from other manufacturers. For possible solutions in this regard, please contact our Application Technology department *(support@vonroll-hydro.world)*.

Installation lengths
Unless otherwise stated, installation lengths "L_u" of the fittings of series A comply with EN 545.

Flange fittings (see Chapter 6)
When ordering flange fittings, nominal pressure level "PN" must be specified. Accessories such as hexagon head screws, nuts, washers and flat seals can be obtained from specialist dealers.

Valves and fittings (see Chapter 10)

Coating
All fittings shown below have an epoxy resin coating of at least 250 µm on the inside and outside, unless otherwise stated. The coating complies with EN 14 901 and the requirements of the Quality Assurance Association for Heavy-Duty Corrosion Protection (GSK). Optionally and subject to availability, can also be supplied with enamelling according to EN ISO 11 177. This means that all fittings in accordance with EN 545 – Annex D.2.3 – can be installed in ground of any corrosiveness.

Cast fittings are not suitable for shortening. For notes on the applications of the coating, see Chapter 7.

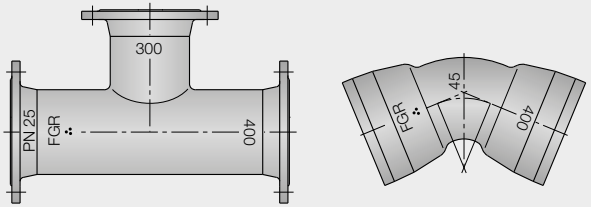
Permissible component operating pressure (PFA)

DN	PFA [bar]	
	BLS	Flange
80 – 250	100	PFA = PN
300	85	
400	30	
500	30	
600	40	
700	25	
800	25	
900	25	
1000	25	

PFA: Maximum permissible component operating pressure in bar
PMA = 1.2 × PFA (highest permissible component operating pressure for a short time, e.g. pressure surge)
PEA = 1.2 × PFA + 5 (permissible component test pressure on the construction site)

Scope of delivery
VONROLL HYDRO supplies fittings and valves, including the necessary seals, locks, segments and safety elements for all sockets. Flat seals, bolts, nuts and washers for flange joints are not included in the scope of delivery.

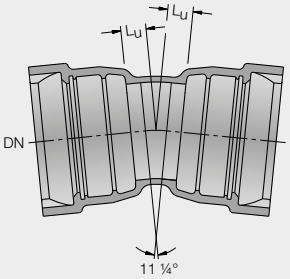
2.3 LABELLING OF FITTINGS



All fittings manufactured by member companies of the "Fachgemeinschaft Gussrohrsysteme/European Association for Ductile Iron Pipe Systems (FGR/EADIPS)" bear the "FGR" mark – an expression of compliance with all guidelines for obtaining the "FGR quality seal". In addition, the fittings are marked with the nominal size and the elbows are marked with the respective centring angle.

For flange fittings, the nominal pressures 16, 25 and 40 are cast on or stamped on. Flange fittings for PN 10 and all socket fittings do not have a nominal pressure specification. To identify the material as "ductile cast iron", the fittings have three raised dots arranged in a triangle (∴) on the outer surface. Additional markings can be stipulated in special cases.

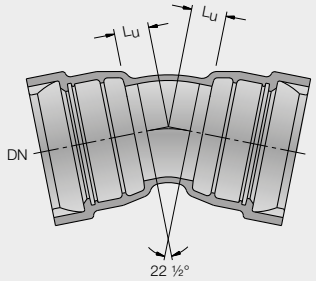
2.3 MMK FITTINGS – 11 BLS
11 ¼° BLS double socket elbows
According to EN 545



DN	Dimensions [mm] Lu	PFA [1] [bar]	Weight ~ [kg]
80	30	100	10.1
100	30		14.0
125	35		18.6
150	35		23.3
200	40		38.2
250	50		52.3
300	55	85	70.4
400	65	30	116.0
500	75		171.5
600	85	40	186.0
700	95	25	277.0
800	110		378.0
900	120		532.0
1000	130		614.0

1) When using clamping rings and plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.

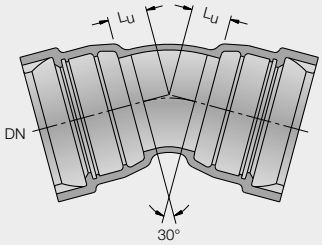
2.3 MMK FITTINGS – 22 BLS
22½° BLS double socket elbows
According to EN 545



DN	Dimensions [mm] Lu	PFA [1] [bar]	Weight ~ [kg]
80	40	100	10.2
100	40		14.3
125	50		19.4
150	55		24.3
200	65		39.2
250	75		56.9
300	85	85	78.6
400	110	30	125.5
500	130		197.0
600	150	40	215.5
700	175	25	320.0
800	195		458.0
900	220		594.0
1000	240		723.0

1) When using clamping rings and plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.

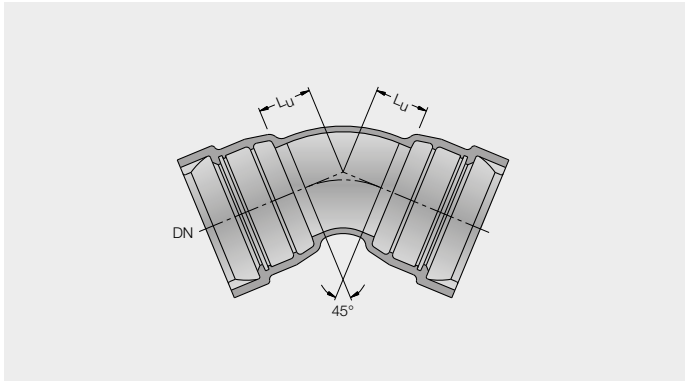
2.3 MMK FITTINGS – 30 BLS
30° BLS double socket elbows
According to EN 28 650



DN	Dimensions [mm] Lu	PFA [1] [bar]	Weight ~ [kg]
80	45	100	10.4
100	50		14.7
125	55		20.3
150	65		25.2
200	80		41.4
250	95		59.3
300	110	85	79.9
400	140	30	137.0
500	170		205.5
600	200	40	230.0
700	230	25	333.0
800	260		473.0
900	290		635.0
1000	320		809.0

1) When using clamping rings and plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.

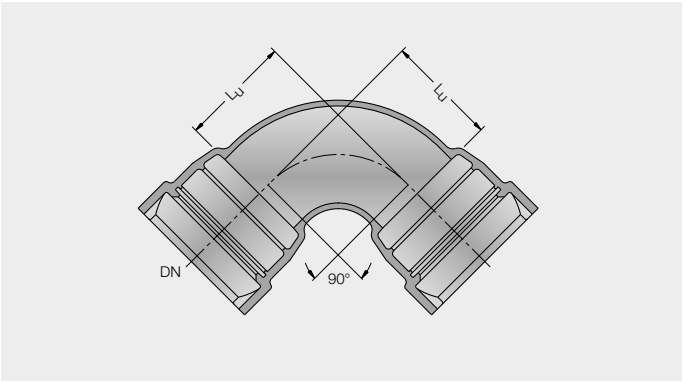
2.3 MMK FITTINGS – 45 BLS
45° BLS double socket elbows
According to EN 545



DN	Dimensions [mm] Lu	PFA [1] [bar]	Weight ~ [kg]
80	55	100	11
100	65		14.7
125	75		20.8
150	85		26.3
200	110		41.5
250	130		65.1
300	150	85	86.4
400	195	30	149.5
500	240		227
600	285	40	261
700	330	25	376
800	370		548
900	415		716
1000	460		879

1) When using clamping rings and plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.

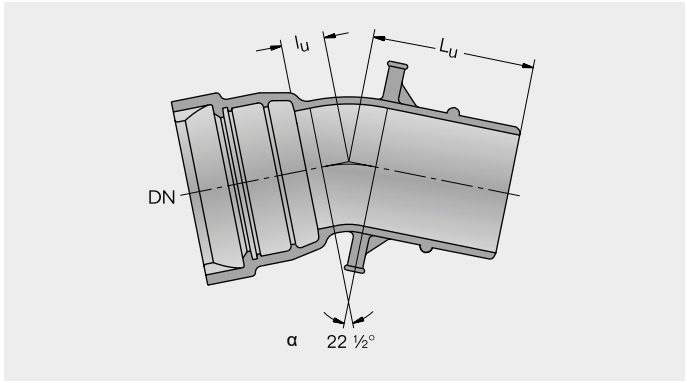
2.3 MMQ FITTINGS – BLS
90° BLS double socket elbows
According to EN 545



DN	Dimensions [mm] Lu	PFA [1] [bar]	Weight ~ [kg]
80	100	100	11.6
100	120		15.9
125	145		22.4
150	170		28.9
200	220		55.1
250	270		76.0
300	320	85	94.5
400	430	30	200.5

1) When using clamping rings and plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.

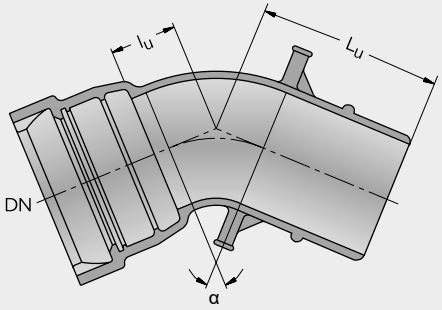
2.3 MK FITTINGS – 11 AND 22 BLS
11° and 22° BLS elbow sockets
In accordance with company standard



DN	Dimensions [mm] lu	Lu	PFA [1] [bar]	Weight ~ [kg]
		α = 11¼°		
80	30	175	100	8.4
100	30	185		11.1
125	35	200		15.1
150	35	210		20.1
200	40	230		32.7
250	50	250		51.0
300	55	270	85	71.0
400	65	375	63	125.0
500	75	405	50	220.0
		α = 22½°		
80	40	185	100	8.7
100	40	195		11.6
125	50	215		15.9
150	55	230		21.5
200	65	255		35.3
250	75	275		53.0
300	85	300	85	73.0
400	110	420	63	138.8
500	130	460	50	220.0

1) When using clamping rings and plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.

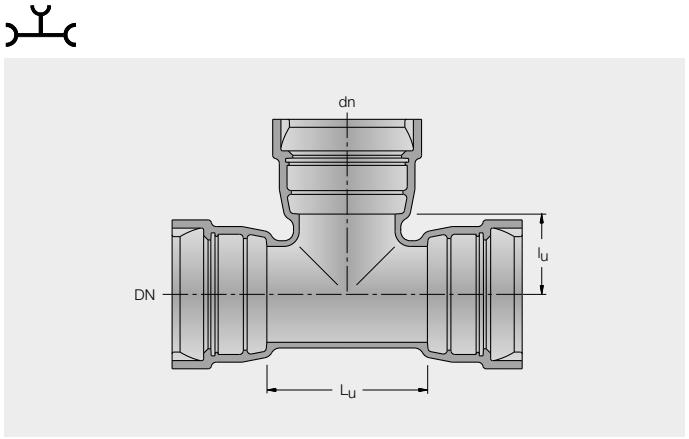
2.3 MK FITTINGS – 30 AND 45 BLS
30° and 45° BLS elbow sockets
In accordance with company standard



DN	Dimensions [mm] lu	Lu	PFA [1] [bar]	Weight ~ [kg]
		α = 30°		
80	45	190	100	8.9
100	50	205		11.9
125	55	220		16.2
150	65	240		22.4
200	80	270		36.5
250	95	295		57.0
300	110	320		82.0
400	140	450	63	157.2
500	170	495	50	224.0
		α = 45°		
80	55	200	100	9.1
100	65	220		12.3
125	75	240		17.0
150	85	260		24.2
200	110	300		39.7
250	130	335		60.5
300	150	365		87.3

1) When using clamping rings and plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.

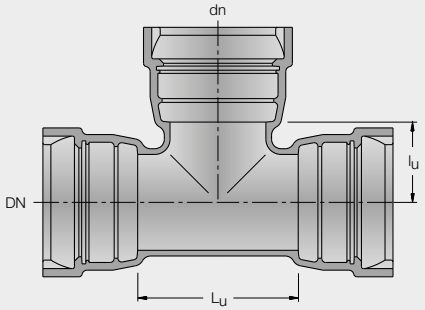
2.3 MMB FITTINGS – BLS
Double socket pieces with a 90° BLS branched socket
According to EN 545



DN	dn	Dimensions [mm] Lu	lu	PFA[1] [bar]	Weight ~ [kg]
80	80	170	85	100	16.1
100	80	170	95		20.0
	100	190	95		22.4
125	80	170	105		25.1
	100	195	110		28.1
	125	225	110		31.0
150	80	170	120		33.6
	100	195	120		34.5
	125	255	125		39.0
	150	255	125		41.1
200	80	175	145		46.2
	100	200	145		47.3
	125	255	145		50.0
	150	255	150		54.3
	200	315	155		63.1
250	80	180	170		72.0
	100	200	170		63.9
	125	230	175		78.0
	150	260	175		70.6
	200	315	180		77.8
	250	375	190		89.1

1) When using clamping rings and plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.

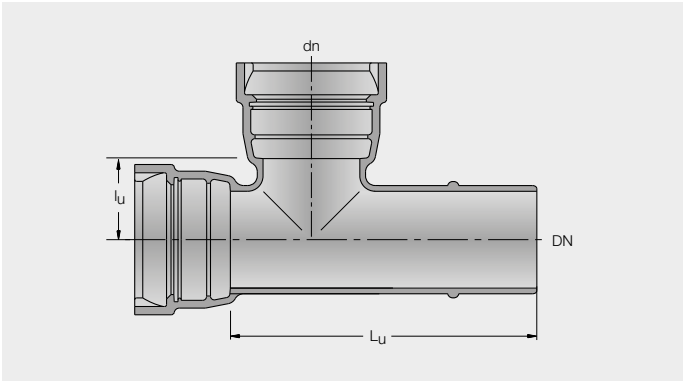
2.3 MMB FITTINGS – BLS
Double socket pieces with a 90° BLS branched socket
According to EN 545



DN	dn	Dimensions [mm] Lu	lu	PFA[1] [bar]	Weight ~ [kg]
300	80	180	195	85	93.0
	100	205	195		80.2
	150	260	200		88.6
	200	320	205		96.6
	250	375	210		109.0
	300	435	220		127.4
400	400	560	280	30	236.0
500	500	800	400	30	396.8

1) When using clamping rings and plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.

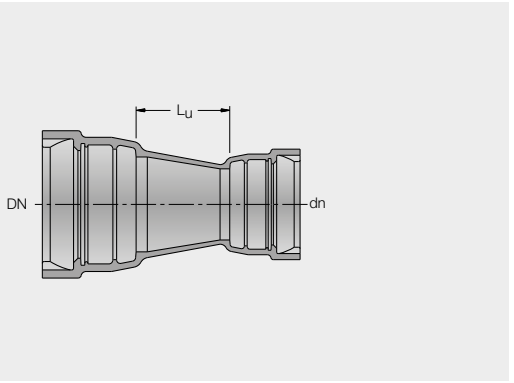
2.3 MB FITTINGS – BLS
Socket head end pieces with 90° BLS branched socket
In accordance with company standard



DN	dn	Dimensions [mm] Lu	lu	PFA[1] [bar]	Weight ~ [kg]
400	80	680	270	63	179.5
400	300	680	270	63	211.5

1) When using clamping rings and plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.

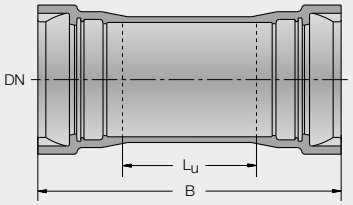
2.3 MMR FITTINGS – BLS
BLS double socket transition pieces
According to EN 545



DN	dn	Lu [mm]	PFA[1] [bar]	Weight ~ [kg]
100	80	90	100	12.3
125	80	140		15.9
	100	100		16.7
150	80	190		19.9
	100	150		20.8
	125	100		21.0
200	100	250		29.6
	150	150		30.4
250	150	250		45.3
	200	150		46.7
300	150	350	85	57.0
	200	250		58.9
	250	150		62.8
400	300	260	30	111.0
500	400	260		148.0

1) When using clamping rings and plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.

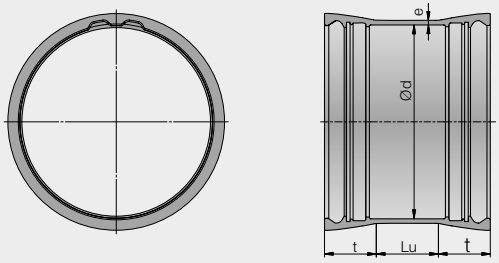
2.3 U FITTINGS – BLS
BLS push-on sockets
According to EN 545



DN	Lu [mm]	B [mm]	PFA [1] [bar]	Weight ~ [kg]
80	161*	415	100	13.4
100	160*	430		16.0
125	174*	460		24.0
150	180*	480		30.5
200	180*	500		45.5
250	190*	520		66.5
300	200*	540	85	83.5
400	210*	590	30	115.0
500	320*	720 *		210.0

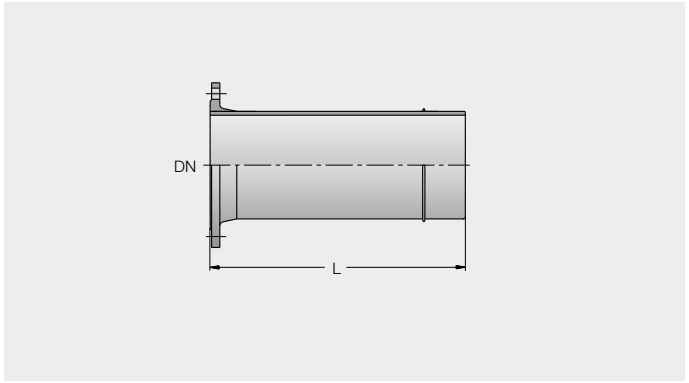
U fittings with a BLS joint can only be completely pushed on to a limited extent.
* In accordance with company standard. Used exclusively with TYTON seals.
1) When using clamping rings and plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.

2.3 MM FITTINGS – BLS
BLS push-on sockets
According to EN 545



DN	Dimensions [mm] Ød	Enamelled cast iron	t	Lu	Weight ~ [kg]	PFA [bar]
600	655	15.4	175	210	186.0	40
700	760	16.8	197	220	281.5	25
800	865	18.2	209	230	369.0	35
900	970	19.6	221	240	585.0	30
1000	1075	21.0	233	250	612.0	25

2.3 F FITTINGS – BLS
BLS single-flange fittings
According to EN 545

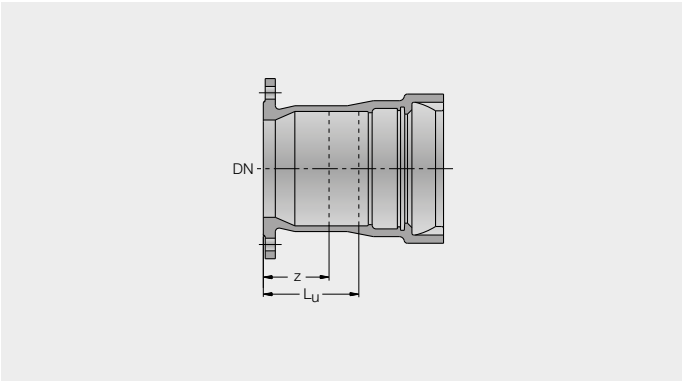


DN	L [mm]	Weight ~ [kg] PN 10 [1]	PN 16 [1]	PN 25 [1]	PN 40 [1]	PN 63 [1]	PN 100 [1]
80	350		7.5			11.9	11.2
100	360	8.5		10.4		14.1	15.7
125	370	12.4		13.1	14.3	20.0	22.8
150	380	19.3		21.0	21.0	31.9	28.0
200	400	25.2	25.2	26.0	30.8	46.6	55.4
250	420	35.1	35.2	37.7	45.4	–	–
300	440	46.0	44.8	49.1	62.0	–	–
400	480	104.0	109.0	114.0	154.0 *	–	–
500	520	146.0	156.0	161.0	–	–	–
600	560	134.3	160.3	174.3	235.3	–	–
700	600	180.6	195.6	229.6	–	–	–
800	600	228.0	247.0	296.0	–	–	–
900	600	348.0	359.0	–	–	–	–
1000	600	503.0	538.0	–	–	–	–

* Observe the PFA of the BLS joint. 1) When using plastic locks,
the pressure specifications and the instructions for use on page 58 must be observed.

ANSI fittings on request.

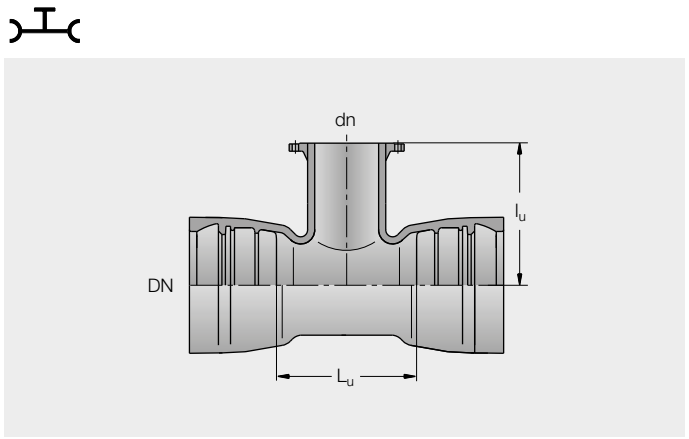
2.3 EU FITTINGS – BLS
BLS flange socket pieces
According to EN 545



DN	L [mm]	z [mm]	Weight ~ [kg] PN 10 [1]	PN 16 [1]	PN 25 [1]	PN 40 [1]	PN 63 [1]	PN 100 [1]
80	130	90		10.2			12.3	–
100	130	90	12.2		12.7		16.3	20.7
125	135	95	15.5		17.0	17.0	26.8	–
150	135	95	19.9		22.1	22.1	31.5	33.4
200	140	100	28.7	28.9	29.6	34.6	49.0	56.4
250	145	105	40.6	39.7	44.3	51.9	67.5	86.4
300	150	110	52.3	52.1	56.1	69.9	84.9	120.0
400	160	120	90.0	89.0	102.0	127.5	–	–
500	170	130	125.0	140.5	151.0	162.0 *	–	–
600	180	140	137.5	167.5	173.5	209.0 *	–	–
700	190	150	202.0	248.0	278.0	–	–	–
800	200	160	269.5	270.0	316.0	–	–	–
900	210	170	347.0	370.0	427.0	–	–	–
1000	220	180	439.0	464.0	549.0	–	–	–

Lu = installation length when locked z = average installation length (when used without weld bead)
* Observe the PFA of the BLS joint
1) When using clamping rings and plastic locks, the pressure specifications and the instructions
for use on page 58 must be observed.

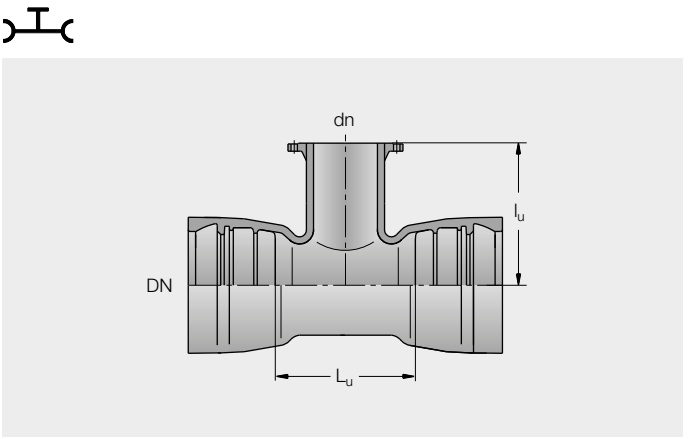
2.3 MMA FITTINGS – BLS
Double socket pieces with BLS flanged branch
According to EN 545



DN	dn	Lu [mm]	lu	Weight ~ [kg] PN 10 [1)]	PN 16 [1)]	PN 25 [1)]	PN 40 [1)]
80	80	170	165	15.8	15.8	15.8	15.8
100	80	170	175	20.5	20.5	20.5	20.5
	100	190	180	21.9	21.9	–	
125	80	170	190	24.8	24.8	24.8	24.8
	100	195	195	27.6	27.6	–	
150	80	170	205	30.6	30.6	30.6	30.6
	100	195	210	33.0	33.0	–	
	150	225	220	39.0	39.0	–	
200	80	175	235	45.4	45.4	45.4	45.4
	100	200	240	46.8	46.8	–	
	150	250	250	51.6	51.6	–	
	200	315	260	–	57.0	–	
250	80	180	265	56.0	56.0	56.0	56.0
	100	200	270	57.5	57.5	–	
	150	260	280	63.5	63.5	–	
	200	315	290	–	71.5	–	
	250	375	300		–		
300	80	180	295	76.6	76.6	76.6	76.6
	100	205	300	81.2	81.2	–	
	150	260	310	80.0	80.0	–	
	200	320	320		–		
	300	435	340	110.0		–	
400	150	270	370	148.0	148.0	152.0	152.0
	200	440	380	170.0	171.0	173.0	–
	300	440	400	191.0	192.0	197.0	–
	400	560	420	200.0	205.0	217.0	–

1) When using clamping rings and plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.

2.3 MMA FITTINGS – BLS
Double socket pieces with BLS flanged branch
According to EN 545



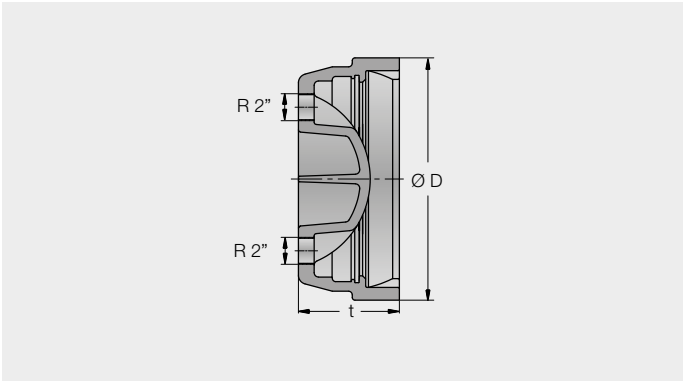
DN	dn	Lu [mm]	lu	Weight ~ [kg] PN 10 [1)]	PN 16 [1)]	PN 25 [1)]	PN 40 [1)]
500	200	450	440	192.5	192.5	194.5	–
	300	450	460	205.0	205.0	211.0	–
	400	565	480	297.0	303.0	315.0	–
	500	680	500	338.0	362.0	363.0	372.0 *
600	150	570	490	237.0	237.0	238.0	–
	200		500	254.0	254.0	247.0	–
	300		520	266.0	266.0	272.0	–
	400		540	279.0	284.0	296.0	–
	600	800	580	376.5	401.0	415.0	–
800	150	1045	580	657.0	657.0	645.0	–
	200		585	667.0	667.0	655.0	–
	400		615	695.0	682.0	693.0	–
	600		645	745.0	770.0	784.0	–
	800		675	791.0	809.0	855.0	–
1000	100	480	690	672.0	738.0	745.0	–
	125		695	673.0	738.0	746.0	–
	150		700	675.0	739.0	747.0	–
	200		705	678.0	741.0	750.0	–
	250		715	682.0	741.0	750.0	–
	300		720	687.0	748.0	760.0	–

* Observe the PFA of the BLS joint. 1) When using clamping rings and plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.

2.3 O FITTINGS – BLS

BLS spigot end sealing cap

In accordance with company standard



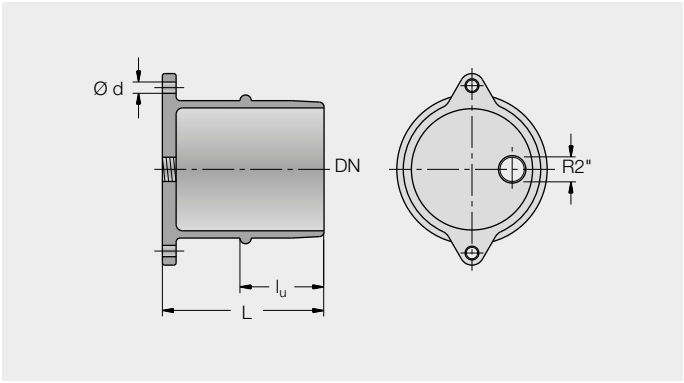
DN	t [mm]	D [mm]	PFA[1] [bar]	Weight [kg]
400	225	540	30	117
500	240	650	30	170

1) When using clamping rings and plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.

2.3 P PLUG – BLS

BLS socket sealing plug

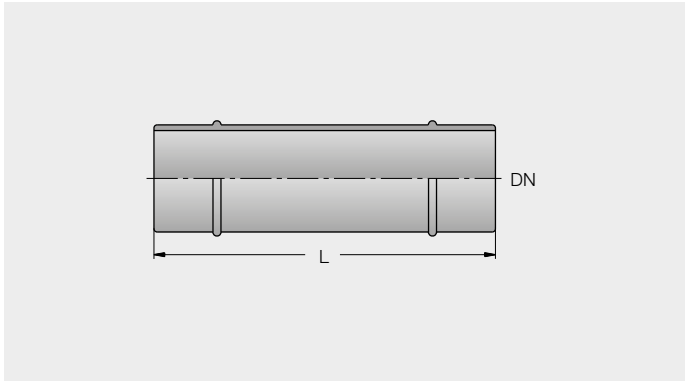
In accordance with company standard



DN	Lu [mm]	lu [mm]	d [mm]	PFA[1] [bar]	Weight [kg]
80	170	86	M 12		4.1
100	175	91	M 12		4.4
125	195	96	M 16		6.7
150	200	101	M 16	100	9.2
200	210	106	M 16		14.5
250	250	106	M 20		27.2
300	300	106	M 20		49.4

1) When using plastic locks, the pressure specifications and the instructions for use on page 25 must be observed. Available with Whitworth (Europe) and NPT (North America) thread

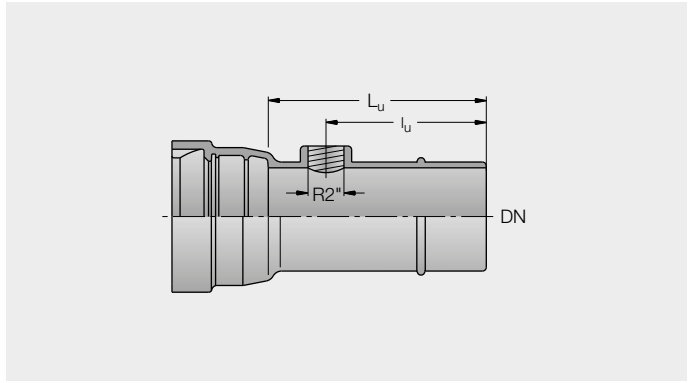
2.3 GL FITTINGS (GDR FITTINGS) – BLS
Smooth pipes with two weld beads
In accordance with company standard



DN	Weight [kg] PFA [bar] 10 [1]	16 [1]	25 [1]	30 [1]	40 [1]	63 [1]	100 [1]	Inner/outer coating
L = 400 mm or 800 mm								
80				7.6 or 15.4				Epoxy/epoxy
100				9.5 or 18.8				
125				12.0 or 25.0				
150				15.6 or 31.0				
200				22.0 or 44.0 [2]				
Lu = 800 mm								
250				44.6		66.7		ZMA/ Zink+Epoxy
300		55.8		56.8		98.0		
400			81.3			–		
500			104.0			–		
600			127.6 [3]			–		
700		164.1			–			
800	201.8		219.6		–			
900	240.4		263.2		–			
1000	283.4		310.4		–			

1) When using plastic locks, the pressure specifications and the instructions for use on page 58 must be observed. Deviating lengths on request.
2) PFA 100 with high-pressure locks;
3) Max. PFA 32

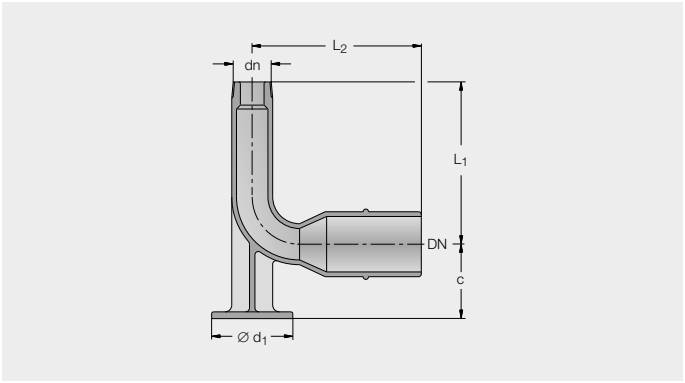
2.3 HAS FITTINGS (A FITTINGS) – BLS
House connection pieces with 2" IT outlet (BLS)
In accordance with company standard



DN	Lu [mm]	lu [mm]	PFA [1] [bar]	Weight [kg]
80	305	215	100	10.5
100	315	225		13.8
125	325	235		17.8
150	340	250		23.1
200	355	265		34.8
250	370	275		54.0
300	380	285	85	72.0

1) When using clamping rings and plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.
Available with Whitworth (Europe) and NPT (North America) thread

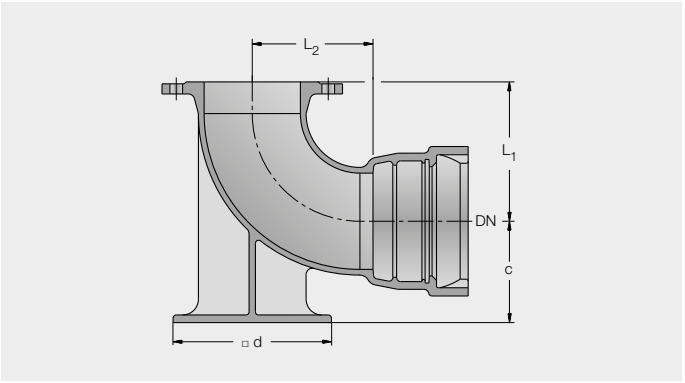
2.3 ENH FITTINGS – BLS
90° hydrant foot bends with ET (BLS)
In accordance with company standard



DN	Dimensions [mm]					PFA [1]	Weight
	dn ["]	L1 [mm]	L2 [mm]	c [mm]	d1	[bar]	[kg]
80	1.5	240	250	110	120	100	7.3
80	2.0	240	250	110	120	100	7.3

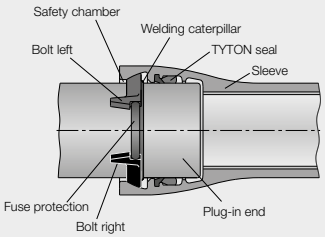
1) When using plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.

2.3 EN FITTINGS – BLS
90° BLS foot bends
In accordance with company standard



DN	Dimensions [mm]				Weight [kg]			
	L1	L2	c	d	PN 10 [1]	PN 16 [1]	PN 25 [1]	PN 40 [1]
80	165	145	110	180		16.4		
100	180	158	125	200	22.6			–

1) When using clamping rings and plastic locks, the pressure specifications and the instructions for use on page 58 must be observed.

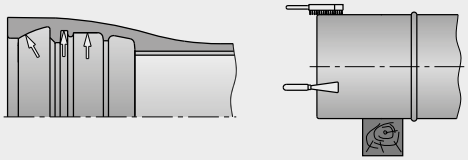


Scope of application

These installation instructions apply to pipes, fittings and valves made of ductile cast iron with longitudinal positive locking BLS push-in socket joints from DN 80 to DN 500. For recommendations for transport, storage and installation, see page 299 et seq. For laying tools and equipment, see Chapter 8.

For very high internal pressures and trenchless installation procedures (e.g. push-pull technique, rocket plough method, burst lining or horizontal drilling technology), a high-pressure lock must additionally be used in nominal sizes DN 80 to DN 250. For permissible tensile forces for trenchless installation procedures, see DVGW worksheets GW 320-1, 321, 322-1, 322-2, 323 and 324. The number of joints to be secured for standard installation in the trench must be specified in accordance with DVGW data sheet GW 368 (**www.eadips.org** – online tools).

2.4 BLS installation instructions
DN 80 to DN 500

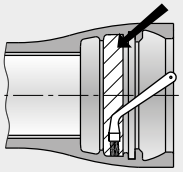


Cleaning

The surfaces marked with an arrow on the seal seat, retaining groove, retaining chamber and locks must be cleaned, and any accumulations of paint must be removed. To clean the retaining groove, use a scraper, e.g. a bent screwdriver. Clean the spigot end. Remove impurities and any colour residues.

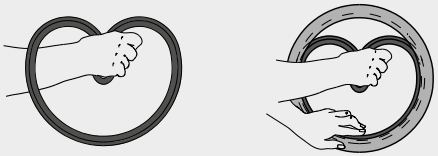
Position of the socket windows in the trench

To insert the locks or bolt the clamping ring, we recommend positioning the socket windows as shown. The position of the fittings depends on the installation situation. For WKG pipes with trace heating, ensure that the heating cable can be positioned in the base.



Inserting the seal
For easier insertion and installation, we recommend applying a little lubricant to the sealing chamber before inserting the seal. To do so, carefully and thinly coat the hatch-marked sealing surface with the lubricant supplied by the pipe manufacturer.

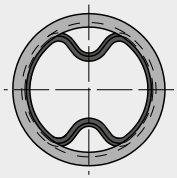
Note: No lubricant must get into the retaining groove (narrow chamber) here. In hot, dry weather (summer), do not apply the lubricant until immediately before installation, otherwise it may dry out. In cold weather (winter), keep the lubricant and seal warm until shortly before use. This makes installation much easier.



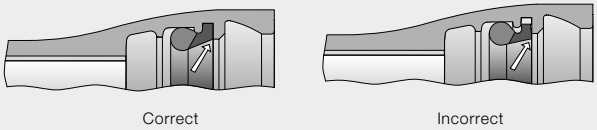
Clean the seal and press it together in a heart shape.

Insert the seal into the socket so that the retaining part (harder rubber part of the TYTON seal) engages completely in the retaining groove of the socket. Then press the loop flat.

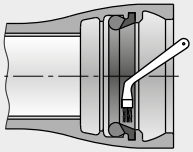
2.4 BLS installation instructions
DN 80 to DN 500



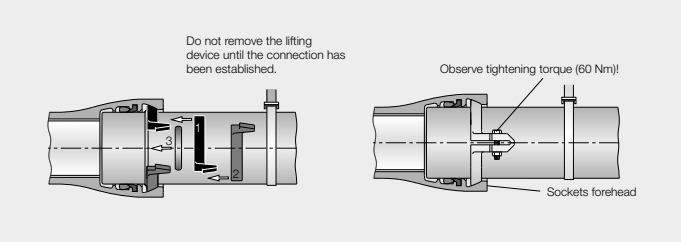
If it is difficult to press the loop flat, pull a second loop on the opposite side. These two small loops can then easily be pressed flat.



The retaining part of the seal must not stick out over the centring collar.



Apply a thin layer of lubricant to the seal. In hot, dry weather (summer), do not apply the lubricant until immediately before installation, otherwise it may dry out. In cold weather (winter), keep the lubricant warm until shortly before use. This makes installation much easier.



Spigot end with a weld bead
Apply a thin layer of lubricant to the cleaned spigot end – especially at the chamfers – and then pull or push it in up to the base of the socket (as far as it will go). The pipes must not be angled when pulling in and inserting the locks.

Insert the "right" lock (1) into the socket window and push it to the right as far as it will go.

Insert the "left" lock (2) into the socket window and push it to the left as far as it will go.

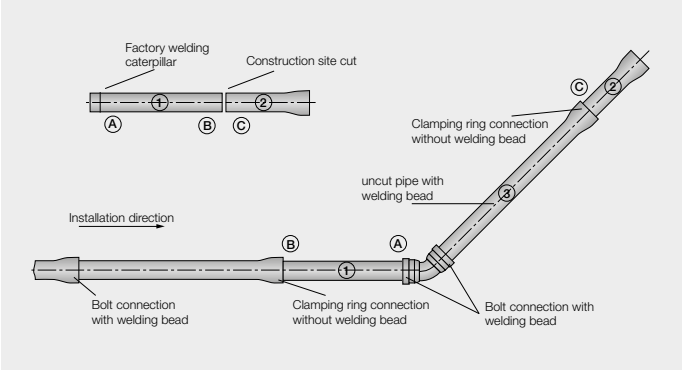
After inserting the locks, press the *safety catch (3)* into the gap between the locks.

From DN 300, steps 1 to 3 must be carried out twice, as 2×2 locks and 2 safety catches are used here.

Spigot end without a weld bead
The two clamping ring halves are first inserted separately into the retaining chamber and loosely connected with the two bolts.

Mark the insertion depth (socket depth) at the spigot end
Apply lubricant to the cleaned spigot end – especially at the chamfers – and then pull or push it in as far as it will go. The pipes must not be angled when pulling in. The previously applied marking on the spigot end should be almost congruent with the front face of the socket after insertion. Pull the clamping ring as far as possible towards the front face of the socket, and then tighten the bolts to 60 Nm using a torque wrench.

2.4 BLS installation instructions
DN 80 to DN 500

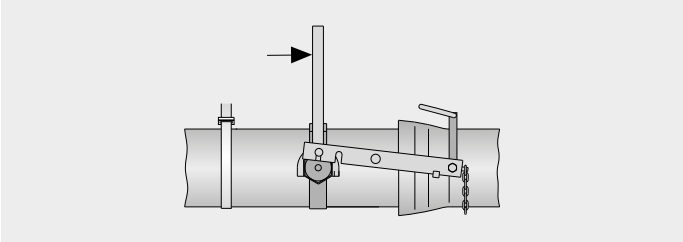


Note on clamping ring joints
When installing clamping rings, it must be ensured that they are not used in exposed pipes, in pulsating pipelines installed in the ground or for trenchless installation procedures. In MK, MMK, MMQ, EN or ENQ fittings, the PFA is a maximum of 16 bar – greater than 16 bar on request.

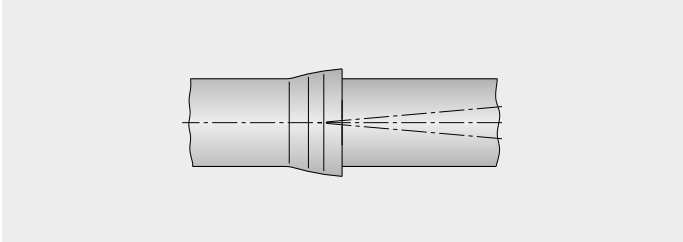
For installation in elbows with an operating pressure >16 bar, the cut adapter pipe (1) with the two spigot ends is rotated by 180°, so that the end with the weld bead (A) is pushed into the socket of the bend. The end without the weld bead (B) is installed in the previous pipe socket using a clamping ring.

Before installing the remaining short pipe with socket (2), an uncut pipe (3) is laid, in the socket of which the spigot end without weld bead (2) is then used with a clamping ring. The installation of clamping rings in culvert pipes and bridge pipelines, as well as for steep slopes, protective pipes, exposed pipes, pulsating pipes or collectors, must be avoided. Our Application Technology department is available for alternative solutions.

The required adapter pipes should be provided with weld beads.



Locking
Pull or push the pipe out of the socket until it comes into contact with the locks or the clamping ring in the retaining chamber, e.g. using a laying tool. The joint is now longitudinal positive locking.

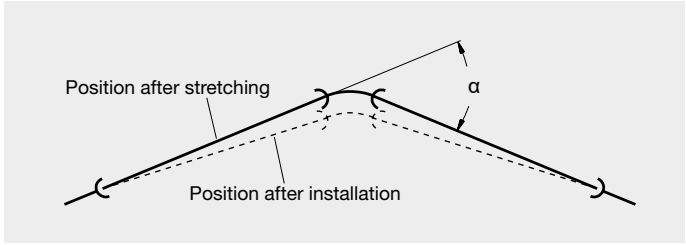


Bending
Once the joint has been completed, pipes and fittings can be bent:

DN 80 to DN 150	– maximum 5°
DN 200 to DN 300	– maximum 4°
DN 400 and DN 500	– maximum 3°

1° deflection results in a deviation of approx. 10 cm from the axis of the previously installed pipe or fitting over a pipe length of 6 m; e.g. at 3° = 30 cm.

2.4 BLS installation instructions
DN 80 to DN 500



Mounting instructions
It should be noted that, depending on the internal pressure and the joint tolerances, stretching of up to approx. 8 mm per joint can occur. In order to take account of the stretching path of the pipe during the application of pressure, the joints at the elbows are set to negative with the max. permissible deflection.

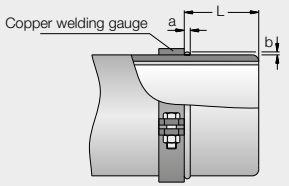
Cutting pipes to length
Ensure that the pipes can be cut (see page 316). If pipes have to be shortened on the construction site, the weld bead required for a BLS push-in socket joint must be attached using an electrode specified by the manufacturer. Execution of welding work in accordance with the DVS 1502 data sheet.

The distance from the spigot end and the bead size must be adhered to in accordance with the table below.

Electrode type: E.g. Castolin 7330-EC; UTP FN 86; ESAB OK 92.58; Gricast 31 or 32. The electrode diameter should be 3.2 mm. From DN 400, it should be 4.0 mm.

DN	80	100	125	150	200	250	300	400	500
L [mm]	86±4	91±4	96±4	101±4	106±4	106±4	106±4	115±5	120±5
a [mm]	8±2	8±2	8±2	8±2	9±2	9±2	9±2	10±2	10±2
b [mm]	5*	5*	5*	5*	5.5*	5.5*	5.5*	6*	6*

* +0.5/-1



To ensure a good and uniform weld bead design, a copper welding jig must be secured to the spigot end at the specified distance (see table) for the purpose of attachment. The welding zone must be blanked metal. Impurities or zinc and zinc-aluminium coatings must be removed by filing or grinding.

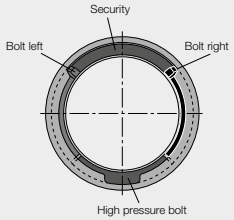
Subsequent application of weld beads to PUR-coated pipes is not possible.

After removing the copper welding jig, the cut edge at the spigot end must be chamfered in accordance with the original design. It must then be cleaned, as must the weld bead area. These areas must be finished off with a protective coating approved for drinking water.

Disassembly
Insert the pipe axially into the socket as far as it will go. Remove the safety catch from the socket window. Move the lock and remove it from the socket window. Use a flat object (e.g. screwdriver) to push the high-pressure lock, if present, out of the base towards the socket window, then remove it.

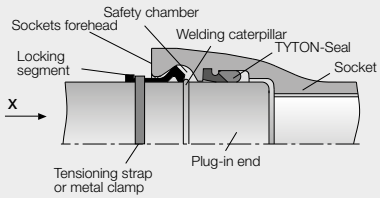
Disassembly of clamping ring joints
Insert the pipe axially into the socket as far as it will go. After removing the clamping screws, the clamping ring halves must be loosened by lightly tapping them with a hammer. During disassembly, it must be ensured that the clamping ring halves are loosely positioned (if necessary, hit them with a hammer while pulling out the spigot end). Clamping a square iron between the clamping straps can also prevent jamming at the spigot end during disassembly. Never hit the socket or pipe shaft with a hammer.

2.4 BLS installation instructions
DN 80 to DN 500



High-pressure lock
For very high internal pressures (e.g. turbine pipes) and trenchless installation procedures (e.g. push-pull technique, burst lining, rocket plough method or horizontal drilling technology), a high-pressure lock must additionally be used for nominal sizes DN 80 to DN 250.
Before the left and right locks are inserted, the high-pressure lock is inserted through the socket window into the retaining chamber and positioned in the base. The locks can now be inserted so that the high-pressure lock lies between their smooth ends. Then, as usual, the locks are fixed with the safety catch. The figure below shows a fully assembled BLS sleeve, including a high-pressure lock.

Special structures
When installing e.g. in casing pipes, on bridges, with the trenchless installation procedure or when using as a culvert pipe, as well as for pipelines on steep slopes, our Application Technology department should be consulted. Pipes on steep slopes should preferably be installed from top to bottom, so that locking due to gravity is maintained after each individual pipe has been stretched. If this procedure is not possible, suitable measures must be taken to prevent locking due to gravity from being done away with.



Scope of application

These installation instructions apply to pipes and fittings made of ductile cast iron with longitudinal positive locking BLS push-in socket joints from DN 600 to DN 1000.

For recommendations for transport, storage and installation, see page 310 et seq. For laying tools and equipment, see Chapter 8.

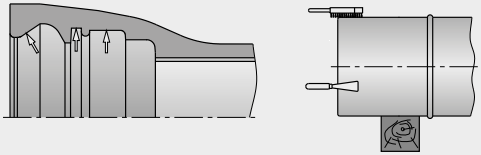
The number of joints to be secured must be specified in accordance with DVGW data sheet GW 368.

For permissible tensile forces for trenchless installation procedures, see DVGW worksheets GW 320-1, 321, 322-1, 322-2, 323 and 324.

Number (n) of retaining segments per joint

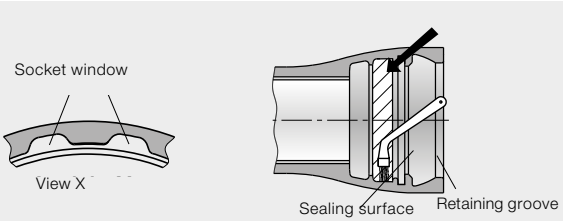
DN	600	700	800	900	1000
n	9	10	10	13	14

2.5 BLS installation instructions
DN 600 to DN 1000



Cleaning

The surfaces marked with an arrow on the seal seat, retaining groove, retaining chamber and retaining segments must be cleaned, and any accumulations of paint must be removed. To clean the retaining groove, use a scraper, e.g a bent screwdriver. Clean the spigot end. Remove impurities and any colour residues.



Position of the socket windows

The socket window in the front end of the socket must always be located in the crown of the pipe.

Inserting the seal

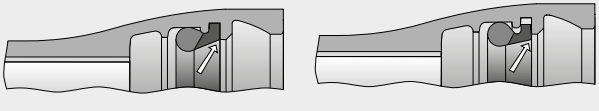
For TYTON seals, lubricant must be used under the seal. To do so, carefully and thinly coat the hatch-marked sealing surface with the lubricant supplied by the pipe manufacturer.

Note: Do not apply lubricant to the retaining groove (narrow chamber). In hot, dry weather (summer), do not apply the lubricant until immediately before installation, otherwise it may dry out.

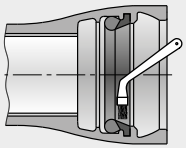
In cold weather (winter), keep the lubricant and seal warm until shortly before use. This makes installation much easier.

Clean the TYTON seal and press it together in a heart shape.

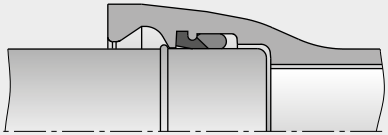
Insert the TYTON seal into the socket so that the retaining part (harder rubber part of the TYTON seal) engages completely in the retaining groove. Then press the loop flat. If it is difficult to press the loop flat, pull a second loop on the opposite side. These two small loops can then easily be pressed flat.



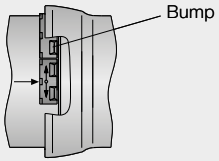
The inner hard rubber edge of the TYTON seal must not stick out over the centring collar.



Apply a thin layer of lubricant to the inserted TYTON seal. In hot, dry weather (summer), do not apply the lubricant until immediately before installation, otherwise it may dry out. In cold weather (winter), keep the lubricant warm until shortly before use. This makes installation much easier.



Assembly of the joint
Apply a thin layer of lubricant to the cleaned spigot end – especially at the chamfers – and then pull or push it in as far as it will go. The pipes must not be angled when pulling in or inserting the locks.



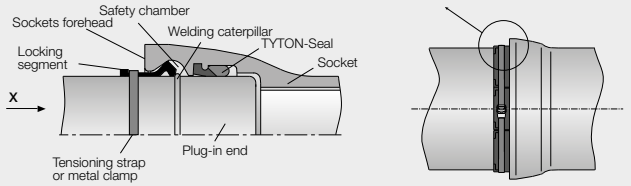
First, insert the retaining segments through the socket windows, except for the last segment, and distribute them alternately left/right over the circumference of the pipe.

Then move all the segments already in the retaining chamber to one side, so that the last segment can be inserted through the socket window and brought into a lock-proof position.

The bumps of the last retaining segment may only be slightly visible in the socket window. If segments are ever jammed, they must be moved into their intended position by lightly tapping the pipe hanging from the belt with a hammer.

Never hit the socket or pipe shaft with a hammer.

2.5 BLS installation instructions
DN 600 to DN 1000

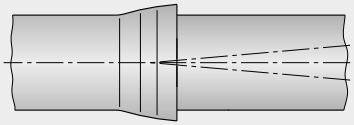


Locking
Pull back all retaining segments outwards as far as they will go against the inclination of the retaining chamber. Then attach the tensioning strap over the segments as shown. Only tension the tensioning strap or metal clamp so gently that the retaining segments can still be moved. Now align the retaining segments. They must be in contact with the pipe shaft across their entire surface and must not overlap. Then tension the tensioning strap or metal clamp tightly enough that the retaining segments are in firm contact over the entire circumference of the pipe. The retaining segments can now no longer be moved. Pull the pipe out of the joint by pulling it axially (e.g. by means of a retaining clamp) until the weld bead comes into contact with the segments. When not angled, the longitudinal distances from the retaining segments to the front face of the socket must be approximately the same. This means that the front sides of the segments must form a line.

Note: For all trenchless installation procedures, a metal clamp is used instead of the tensioning strap.

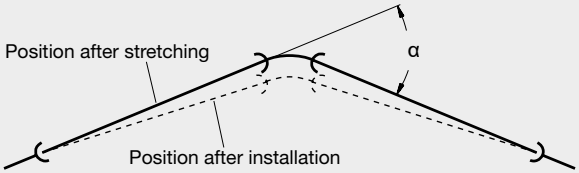
Bending
Once the joint has been completed, pipes and fittings can be bent:

DN	600 – maximum 2.0°
DN	700 – maximum 1.5°
DN	800 – maximum 1.5°
DN	900 – maximum 1.5°
DN	1000 – maximum 1.5°



1° deflection results in a deviation of approx. 10 cm from the axis of the previously installed pipe over pipe lengths of 6 m and 5 m; e.g. at 3° = 30 cm.

Mounting instructions
It should be noted that, depending on the internal pressure, stretching of up to approx. 8 mm per joint can occur through adaptation of the retaining segments. In order to take account of the stretching path of the pipe during the application of pressure, the joints at the elbows are set to negative with the maximum permissible deflection.

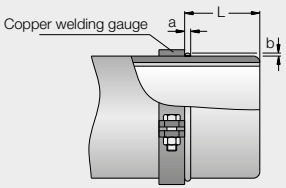


Cutting pipes to length
Ensure that the pipes can be cut (see page 316).

If pipes have to be shortened on the construction site, the weld bead required for a BLS push-in socket joint must be attached using an electrode specified by the manufacturer. Execution of welding work in accordance with the DVS 1502 data sheet.

The distance from the spigot end and the bead size must be adhered to in accordance with the table below. Electrode type: E.g. Castolin 7330-EC; UTP FN 86; ESAB OK 92.58; Gricast 31 or 32.

DN	600	700	800	900	1000
L [mm]	117 +0/-3	135 +0/-3	144 +0/-3	150 +0/-3	160 +0/-3
a [mm]	10 +2/-1	10 +2/-1	10 +2/-1	10 +2/-1	10 +2/-1
b [mm]	6 +0.5/-1	6 +0.5/-1	6 +0.5/-1	6 +0.5/-1	6 +0.5/-1



To ensure a good and uniform weld bead design, a copper welding jig must be secured to the spigot end at the specified distance (see table) for the purpose of attachment.

The welding zone must be blanked metal. Impurities and zinc or zinc-aluminium coatings must be removed by filing or grinding.

Subsequent application of weld beads to PUR-coated pipes is not possible.

After removing the copper welding jig, the cut edge at the spigot end must be chamfered in accordance with the original design. It must then be cleaned, as must the weld bead area. These areas must be finished off with a protective coating approved for drinking water.

Disassembly
Insert the pipe axially into the socket as far as it will go, and remove retaining segments through socket windows.

Special structures
When installing e.g. in casing pipes, on bridges, with the trenchless installation procedure or when using as a culvert pipe, as well as for pipelines on steep slopes, our Application Technology department should be consulted. Pipes on steep slopes should preferably be installed from top to bottom, so that locking due to gravity is maintained after each individual pipe has been stretched. If this procedure is not possible, suitable measures must be taken to prevent locking due to gravity from being done away with.

Subsequent application of weld beads to PUR-coated pipes is not possible.

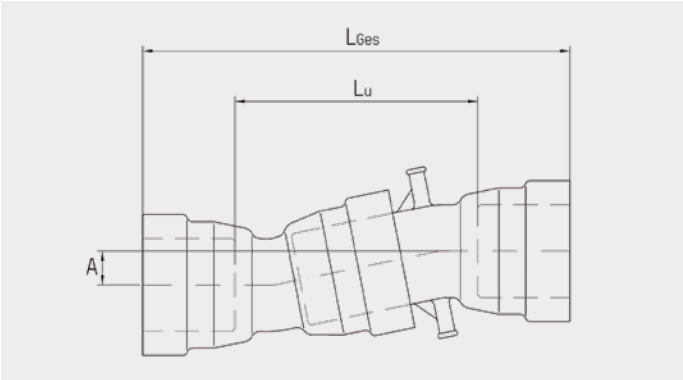
Electrode requirements

Nominal size DN	Electrodes/bead Dia. 3.2 mm [st]		Electrodes/bead Dia. 4.0 mm [st]	Time required per weld bead [min]
80	5			15
100	6			18
125	8			24
150	9		–	27
200	12			36
250	15			43
300	17			50
400	8	+	11	57
500	11	+	14	75
600	13	+	16	87
700	16	+	19	105
800	18	+	22	120
900	21	+	25	138
1000	23	+	27	150

The weld bead is always applied in two layers, with the root layer always being welded with a diameter of 4 mm from DN 400. The electrode requirements and time required that are specified in the table act only as a guide – without handling, cutting, chamfering and repainting.

2.6 Calculation of height offsets with BLS fittings

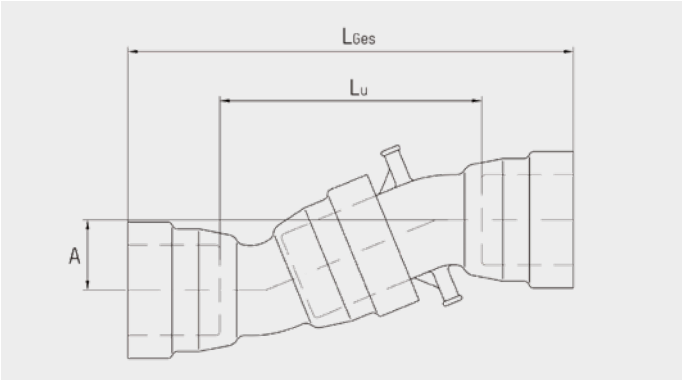
MMK + MK, 11°, DN 80 to DN 500



DN	Dimensions [mm]		
	A	Lu	LGes
80	40	262	516
100	42	271	541
125	46	301	587
150	48	311	611
200	53	345	665
250	59	395	725
300	64	429	769
400	86	562	942
500	94	621	1021

2.6 Calculation of height offsets with BLS fittings

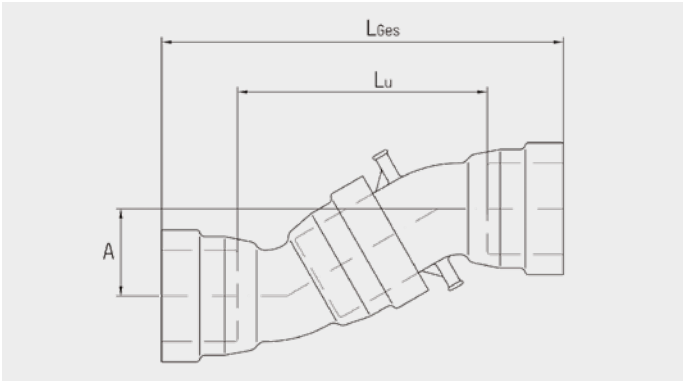
MMK + MK, 22°, DN 80 to DN 500



DN	Dimensions [mm]		
	A	Lu	LGes
80	87	288	542
100	90	298	568
125	102	345	631
150	110	374	674
200	123	426	746
250	134	474	804
300	148	526	866
400	203	710	1090
500	226	806	1206

2.6 Calculation of height offsets with BLS fittings

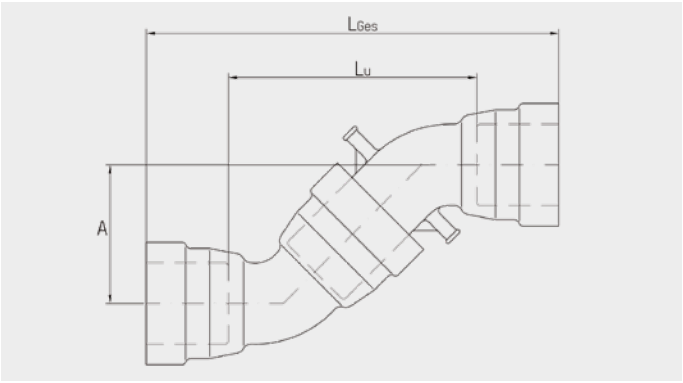
MMK + MK, 30°, DN 80 to DN 500



DN	Dimensions [mm]		
	A	Lu	LGes
80	118	294	548
100	128	321	591
125	138	349	635
150	153	395	695
200	175	464	784
250	195	528	858
300	215	593	933
400	295	791	1171
500	333	916	1316

2.6 Calculation of height offsets with BLS fittings

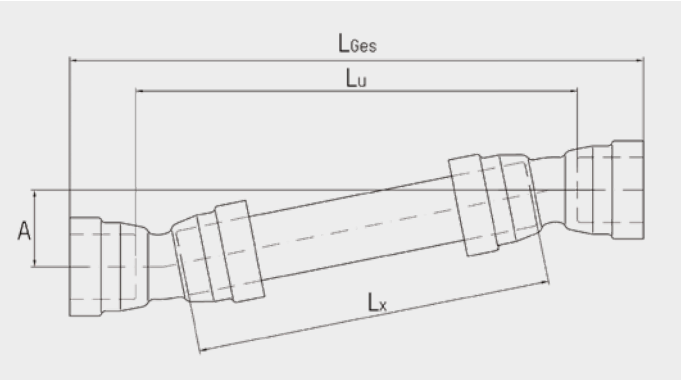
MMK + MK, 45°, DN 80 to DN 300



DN	Dimensions [mm]		
	A	Lu	LGes
80	181	291	545
100	202	332	602
125	223	373	659
150	244	414	714
200	290	510	830
250	329	589	919
300	365	665	1005

2.6 Calculation of height offsets with BLS fittings

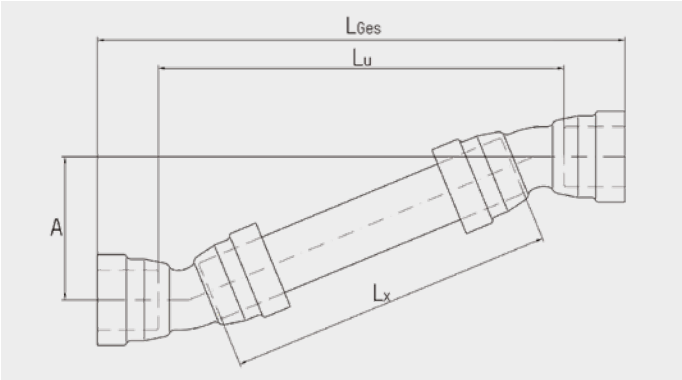
MMK 11° + smooth pipe, 400/800 mm, DN 80 to DN 500



DN	Dimensions [mm]			
	Lx	A	Lu	LGes
80	400	90	513	767
80	800	168	905	1159
100	400	90	513	783
100	800	168	905	1175
125	400	92	533	819
125	800	170	925	1211
150	400	92	533	833
150	800	170	925	1225
200	400	94	553	873
200	800	172	945	1265
250	800	176	985	1315
300	800	178	1004	1344
400	800	182	1044	1424
500	800	186	1084	1484

2.6 Calculation of height offsets with BLS fittings

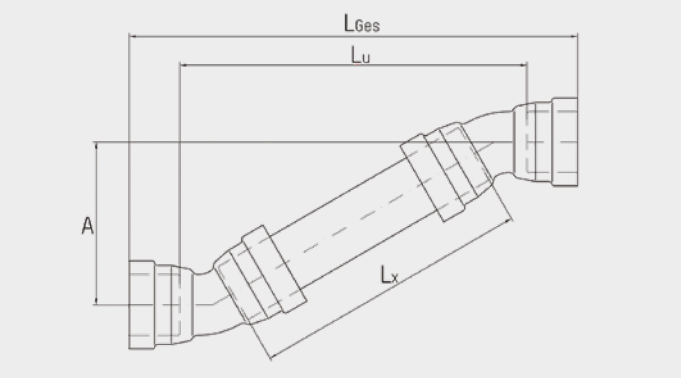
MMK 22° + smooth pipe, 400/800 mm, DN 80 to DN 500



DN	Dimensions [mm]			
	Lx	A	Lu	LGes
80	400	184	525	779
80	800	337	895	1449
100	400	184	525	779
100	800	337	895	1449
125	400	192	564	850
125	800	345	933	1219
150	400	196	583	883
150	800	349	953	1252
200	400	203	622	942
200	800	356	991	1311
250	800	364	1030	1360
300	800	372	1068	1408
400	800	391	1164	1544
500	800	406	1241	1641

2.6 Calculation of height offsets with BLS fittings

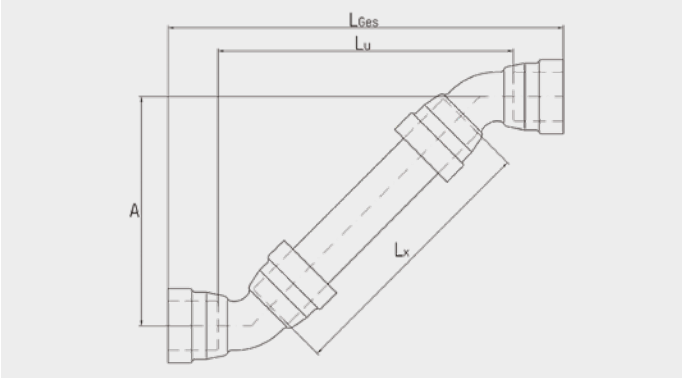
MMK 30°+ smooth pipe, 400/800 mm, DN 80 to DN 500



DN	Dimensions [mm]			
	Lx	A	Lu	LGes
80	400	245	517	771
80	800	445	863	1117
100	400	250	535	805
100	800	450	882	1152
125	400	255	554	840
125	800	455	900	1186
150	400	265	591	891
150	800	465	938	1238
200	400	280	647	967
200	800	480	994	1314
250	800	495	1050	1380
300	800	510	1106	1446
400	800	540	1218	1598
500	800	570	1330	1730

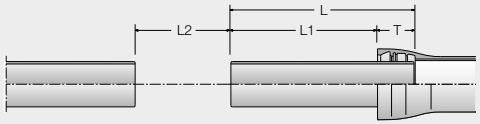
2.6 Calculation of height offsets with BLS fittings

MMK 45°+ smooth pipe, 400/800 mm, DN 80 to DN 500

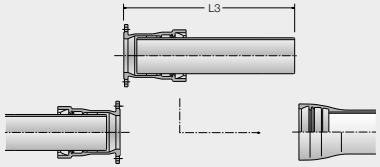


DN	Dimensions [mm]			
	Lx	A	Lu	LGes
80	400	361	473	727
80	800	644	756	1010
100	400	375	507	777
100	800	658	790	1060
125	400	389	542	828
125	800	672	824	1110
150	400	404	575	875
150	800	686	859	1159
200	400	439	661	981
200	800	722	943	1263
250	800	750	1012	1342
300	800	778	1080	1420
400	800	842	1234	1614
500	800	906	1387	1787

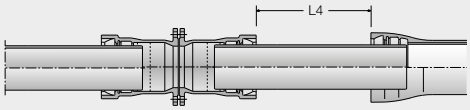
2.7 Repair of BLS cast-iron pipes with EU fittings



Cut out the pipe section of length "L2".



Remove the remaining fitting and push the EU fittings with sealing and clamping ring as far as they will go. Push the second EU fitting with sealing and clamping ring onto the end of the pipe.

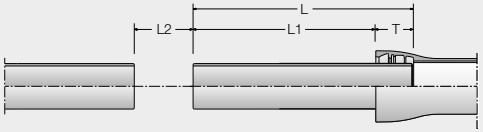


Install the loose pipe section in the pipe socket, then lock it. Push the EU fitting back to dimension "L4" and bolt the clamping ring. Push back the second EU fitting and create the flange joint. Bolt the clamping ring. Please note: Round off cut edges and apply corrosion protection.

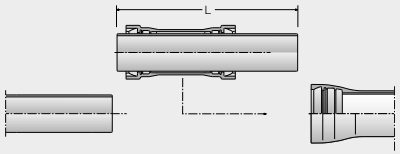
DN	L	L1	L2	L3	L4	T
80	500	373	230	550	230	127
100	500	365	240	550	220	135
125	500	357	250	550	205	143
150	500	350	260	550	195	150
200	600	440	280	655	280	160
250	600	435	290	660	270	165
300	600	430	300	660	260	170
400	600	410	330	670	225	190
500	600	400	360	680	210	200

L is the minimum length. If a length larger than L is selected, L1, L3 and L4 also increase.

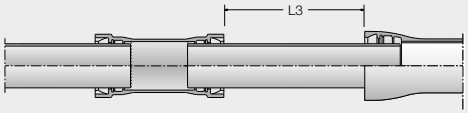
2.7 Repair of BLS cast-iron pipes with U fittings



Cut out the pipe section of length "L2".



Remove the remaining fitting and push on the U fitting. Only insert the sealing and clamping ring into the right-hand socket.



Install the loose pipe section in the pipe socket, then lock it. Push back the U fitting to dimension "L3", inserting the sealing and clamping ring into the left-hand socket when doing so. Tighten the clamping ring screws. Please note: Round off cut edges and apply corrosion protection.

DN	L	L1	L2	L3	T
80	600	473	140	335	127
100	600	465	140	320	135
125	700	557	150	400	143
150	700	550	160	390	150
200	800	640	170	475	160
250	800	635	180	465	165
300	800	630	190	455	170
400	900	710	200	515	190
500	900	700	210	495	200

L is the minimum length. If a length larger than L is selected, L1, L3 and L4 also increase.

HYDRO

3

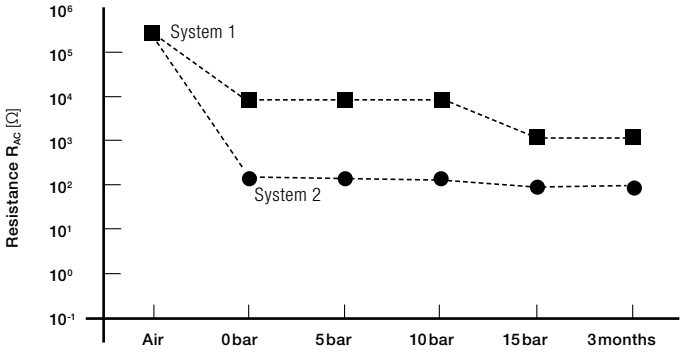
VONROLL HYDROTIGHT – FRICTIONAL SYSTEM TECHNOLOGY

Pipes, fittings and installation instructions

HYDROTIGHT introduction

All joints and joint restraints are identical for pipes and fittings. The VONROLL HYDROTIGHT push-in socket joint system guarantees technical tightness over the entire required service life of the pipe system.
The separation of the sealing and joint restraint functions guarantees maximum safety and reliability. The reinforced full-protection jacket is integrated into the joint here as an individual joint system. This prevents the formation of galvanic elements. Spreading of corrosion currents along the pipe system is completely eliminated.
VONROLL HYDROTIGHT joint restraints can be very easily created in the tightest of spaces. Automatic locking technology makes it ideal for use in densely built-up underground areas in cities, municipalities or transport infrastructure facilities (see "Installation instructions" chapter).

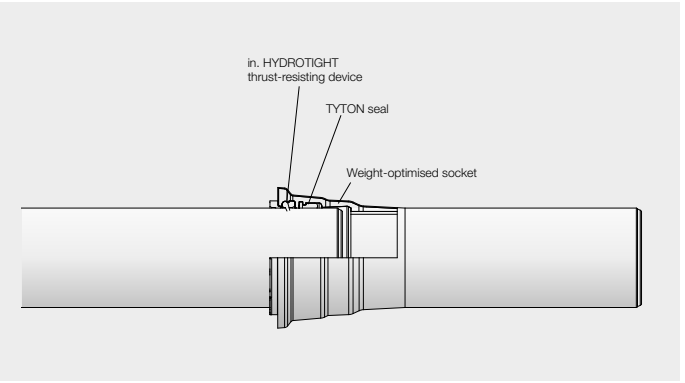
Diagram of alternating current resistance measurements



	Coating	Lining	Joint
System 1	Passive (PUR)	PUR	HYDROTIGHT ext.
System 2	Passive (PUR)	PUR	HYDROTIGHT int.

Product standard – joints – positive or frictional locking

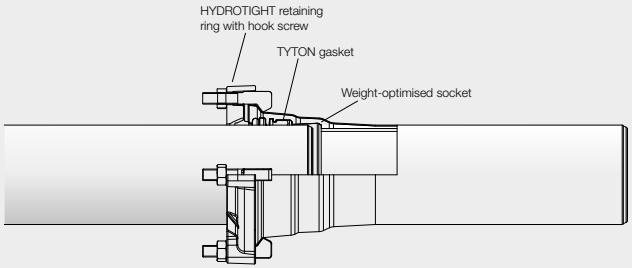
3.1 HYDROTIGHT frictional locking joints
DN 80 to DN 400



DN	C class	PFA * [bar]	Weight [kg] of thrust-resistance ring
80	100	25	0.2
100	100	25	0.3
125	64	25	0.3
150	64	25	0.4
200	64	25	0.6
250	50	25	0.7
300	50	25	0.8
350	50	25	1.3
400	40	16	1.4

* PFA: Permissible component operating pressure; PMA = 1.2 × PFA;
PEA = 1.2 × PFA + 5 – higher PFA on request

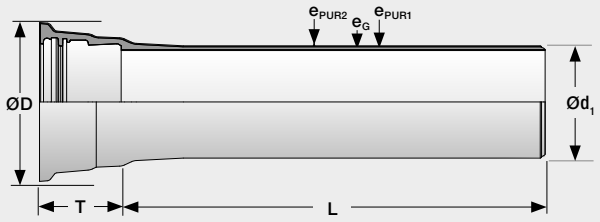
3.1 HYDROTIGHT JOINT
Hydrotight, external
DN 80 to DN 400



DN	Pipe class	PFA * [bar]	External diameter [mm] Locking ring	Weight [kg] Locking ring
80	100	25	235	4.7
100	100	25	256	5.1
125	64	25	287	5.7
150	64	25	310	6.9
200	64	25	325	10.1
250	50	25	421	15.5
300	50	25	179	21.6
350	50	25	534	27.5
400	40	16	595	39.1

* PFA: Permissible component operating pressure;
PMA = 1.2 × PFA; PEA = 1.2 × PFA + 5 – higher PFA on request

3.2 HYDROTIGHT pipes
VONROLL HYDROTIGHT ECOPUR
Drinking water

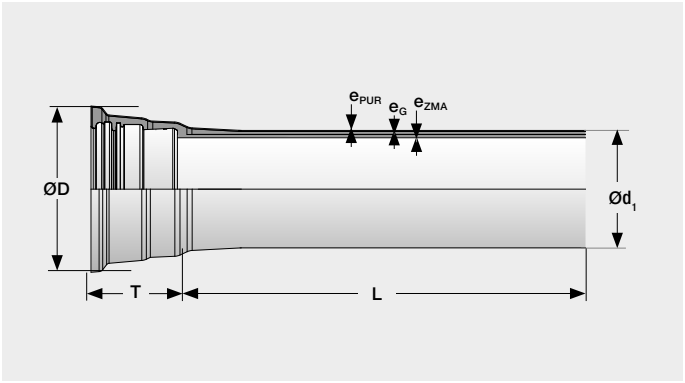


DN	Pipe class	L [mm]	$Ød_1$ [mm] 1)	e_G [mm] 2)	e_{PUR1} [mm] 1)	e_{PUR2} [mm] 1)	ØD [mm]	T [mm]	Density [kg/m³] 3)
80	C 100		98 +1/-2.7	4.7	1.3	0.9	167	119	14.3
100	C 100		118 +1/-2.8	4.7	1.3	0.9	188	120	17.3
125	C 64		144 +1/-2.8	4.0	1.3	0.9	215	123	21.9
150	C 64		170 +1/-2.9	4.0	1.3	0.9	242	126	27.1
200	C 64	6000	222 +1/-3.0	5.0	1.5	0.9	295	131	35.3
250	C 50		274 +1/-3.1	4.8	1.5	0.9	352	131	46.8
300	C 50		326 +1/-3.3	5.7	1.5	0.9	410	130	60.1
350	C 40		378 +1/-3.4	5.3	1.5	0.9	464	135	72.9
400	C 40		429 +1/-3.5	6.0	1.5	0.9	517	145	90.9

1) Nominal; 2) Minimum; 3) Theoretical

External coating: Polyurethane (PUR) EN 15 189
Internal coating: Polyurethane (PUR) EN 15 655-1
Seal: TYTON EPDM

3.2 HYDROTIGHT pipes
VONROLL HYDROTIGHT ECOCEM
Drinking water

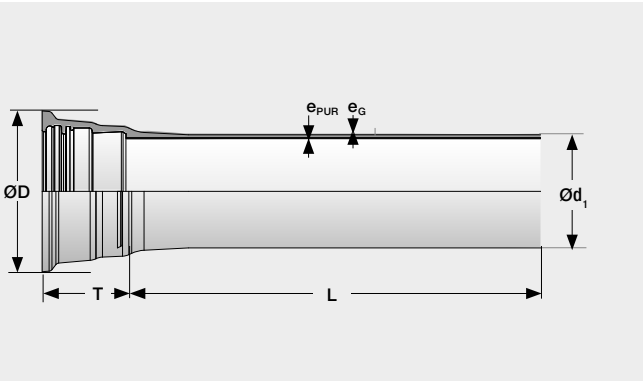


DN	Pipe class	L [mm]	Ød$_1$ [mm] 1)	e_G [mm] 2)	e_{ZMA} [mm] 1)	e_{PUR} [mm] 1)	ØD [mm]	T [mm]	Density [kg/m^3] 3)
80	C 100		98 +1/-2.7	4.7	4.0	0.9	167	119	16.1
100	C 100		118 +1/-2.8	4.7	4.0	0.9	188	120	20.0
125	C 64		144 +1/-2.8	4.0	4.0	0.9	215	123	26.0
150	C 64		170 +1/-2.9	4.0	4.0	0.9	242	126	32.0
200	C 64	6000	222 +1/-3.0	5.0	4.0	0.9	295	131	41.3
250	C 50		274 +1/-3.1	4.8	4.0	0.9	352	131	54.6
300	C 50		326 +1/-3.3	5.7	4.0	0.9	410	130	70.7
350	C 40		378 +1/-3.4	5.3	5.0	0.9	464	135	85.5
400	C 40		429 +1/-3.5	6.0	5.0	0.9	517	145	107.0

1) Nominal; 2) Minimum; 3) Theoretical

External coating: Polyurethane (PUR) EN 15 189
Internal coating: Cement mortar according to EN 2880
Seal: TYTON EPDM

3.2 HYDROTIGHT pipes
VONROLL HYDROTIGHT DUCPUR
Drinking water



DN	Pipe class	L [mm]	Ød$_1$ [mm] 1)	e_G [mm] 1)	e_{PUR} [mm] 1)	ØD [mm]	T [mm]	Density [kg/m^3] 1)
80	C 100		98 +1/-2.7	4.7	1.3	167	119	14.2
100	C 100		118 +1/-2.8	4.7	1.3	188	120	17.1
125	C 64		144 +1/-2.8	4.0	1.3	215	123	21.1
150	C 64		170 +1/-2.9	4.0	1.3	242	126	25.2
200	C 64	6000	222 +1/-3.0	5.0	1.5	295	131	33.3
250	C 50		274 +1/-3.1	4.8	1.5	352	131	46.3
300	C 50		326 +1/-3.3	5.7	1.5	410	130	58.3
350	C 40		378 +1/-3.4	5.3	1.5	464	135	71.9
400	C 40		429 +1/-3.5	6.0	1.5	517	145	86.1

1) Nominal; 2) Minimum; 3) Theoretical

External coating: Zn-Al 400 g/m^2 with finishing layer, blue
Internal coating: Polyurethane (PUR) EN 15 655-1
Seal; TYTON EPDM

3.3 HYDROTIGHT fittings

General information
The fittings are provided with an integral epoxy coating at least 250 µm thick. Coating according to GSK with epoxy resin powder offers high-quality and pore-free corrosion protection.

Valves and fittings for water, district heating (primary circuit) and gas supply, as well as for wastewater disposal, fulfil the requirements of EN 545 Annex D1, reinforced full protection. The extremely smooth and pore-free epoxy internal and external coating offers comprehensive protection for drinking water and meets all legal requirements on hygiene in full. It prevents deposits from building up and is abrasion-resistant. The epoxy coating is an organic protective coating and has minimal environmental impact.

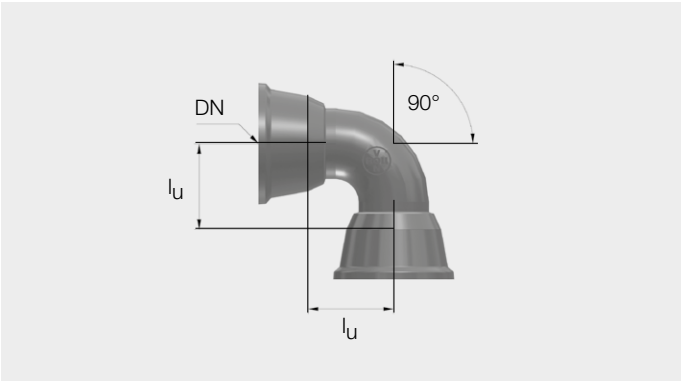
Applications
Ductile socket fittings with HYDROTIGHT sockets (without flanges) are designed for use in drinking water pipes at operating pressures as specified in EN 545:2010-12 Annex A.3 and the table (below).

Permissible component operating pressure (PFA) (unless otherwise stated)

PFA = Maximum permissible component operating pressure in bar
PMA = 1.2 × PFA (highest permissible component operating pressure for a short time, e.g. pressure surge)
PEA = 1.2 × PFA + 5 (permissible component test pressure on the construction site)

Cast fittings are not suitable for shortening.
For notes on the applications of the coating, see Chapter 7.

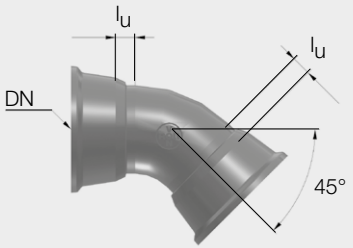
3.3 HYDROTIGHT FITTINGS
MMQ FITTINGS – HYDROTIGHT
90° double socket elbows



DN	l_u [mm]	PFA [bar]	Weight [kg]
80	100	100	8.0
100	125		10.2
125	150	64	14.5
150	175		19.1
200	225		30.5
250	280	50	45.7
300	330		63.7
350	410		140.0
400	420	40	128.0

External/ Internal coating:	thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request
Seal:	TYTON EPDM

3.3 HYDROTIGHT FITTINGS
MMK FITTINGS – HYDROTIGHT
45° double socket elbows

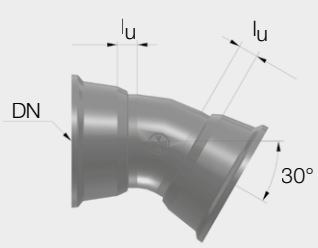


DN	l_u [mm]	PFA [bar]	Weight [kg]
80	55	100	7.1
100	65		8.8
125	75	64	12.3
150	85		15.9
200	110		24.6
250	130	50	35.7
300	155		48.7
350	175		64.9
400	195	40	105.0

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
MMQ FITTINGS – HYDROTIGHT
30° double socket elbows

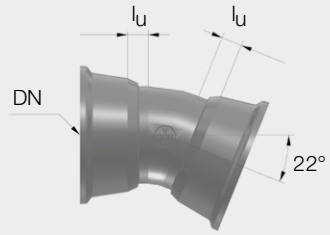


DN	l_u [mm]	PFA [bar]	Weight [kg]
80	45	100	6.8
100	50		8.3
125	55	64	11.6
150	65		14.8
200	80		22.0
250	95	50	32.0
300	110		43.2
350	125		54.5
400	150	40	98.0

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
MMK FITTINGS – HYDROTIGHT
22° double socket elbows

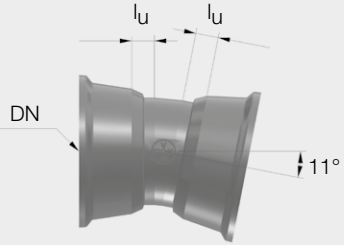


DN	l_u [mm]	PFA [bar]	Weight [kg]
80	40	100	6.7
100	45		8.1
125	50	64	11.2
150	55		14.2
200	65		21.0
250	75	50	30.7
300	90		40.4
350	100		50.7
400	110	40	78.0

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
MMQ FITTINGS – HYDROTIGHT
11° double socket elbows

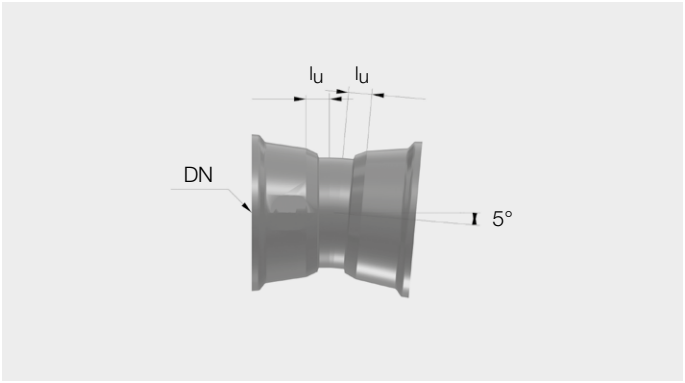


DN	l_u [mm]	PFA [bar]	Weight [kg]
80	30	100	6.5
100	35		7.8
125	35	64	10.6
150	40		13.4
200	45		24.9
250	50	50	34.2
300	60		43.0
350	65		44.9
400	65	40	72.0

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
MMK FITTINGS – HYDROTIGHT
5° double socket elbows

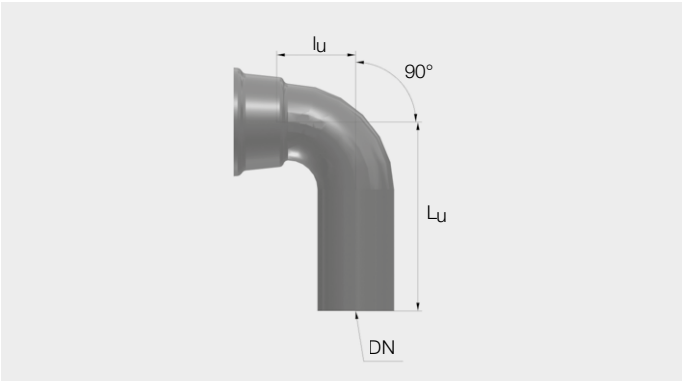


DN	l_u [mm]	PFA [bar]	Weight [kg]
100	30	100	7.8
125	35	64	10.6
150	35		13.4
200	40		24.9
250	50	50	34.2
300	55		43.0
400	60	40	70.0

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
MQ FITTINGS – HYDROTIGHT
90° elbow sockets

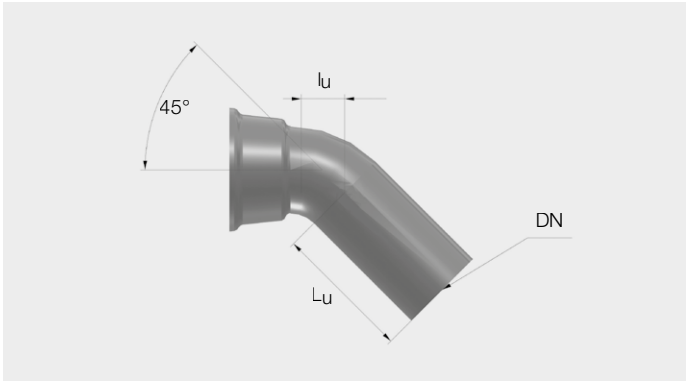


DN	l_u [mm]	L_u [mm]	PFA [bar]	Weight [kg]
80	100	312	100	10.2
100	125	333		11.2
125	150	374	64	16.1
150	175	419		21.5
200	225	491		35.0
250	270	610	50	54.4
300	330	660		76.0
400	420	1175	40	171.0

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
MK FITTINGS – HYDROTIGHT
45° elbow sockets

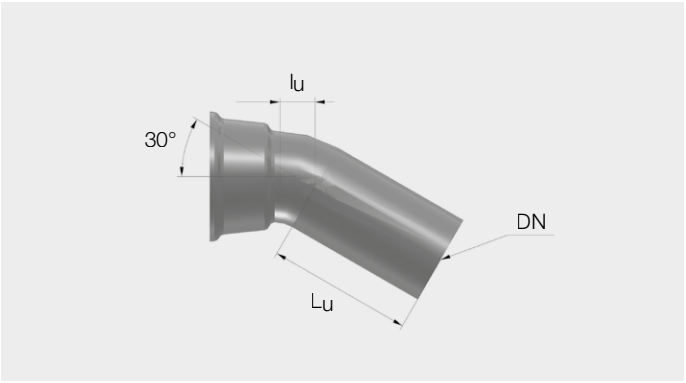


DN	l_u [mm]	L_u [mm]	PFA [bar]	Weight [kg]
80	55	265	100	7.7
100	65	294		9.8
125	75	301	64	13.8
150	85	331		18.3
200	110	374		28.5
250	130	465	50	44.3
300	150	500		60.5
400	195	940	40	136.1

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
MK FITTINGS – HYDROTIGHT
30° elbow sockets

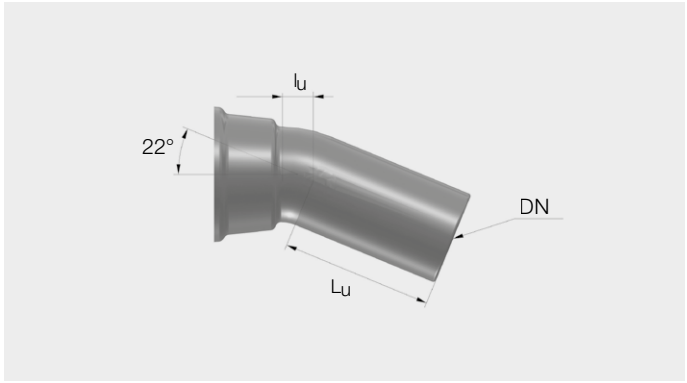


DN	l_u [mm]	L_u [mm]	PFA [bar]	Weight [kg]
80	45	253	100	7.4
100	50	260		9.4
125	55	283	64	13.1
150	65	309		17.2
200	80	345		26.5
250	95	430	50	40.9
300	110	450		54.9
400	150	885	40	124.9

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
MK FITTINGS – HYDROTIGHT
22° elbow sockets

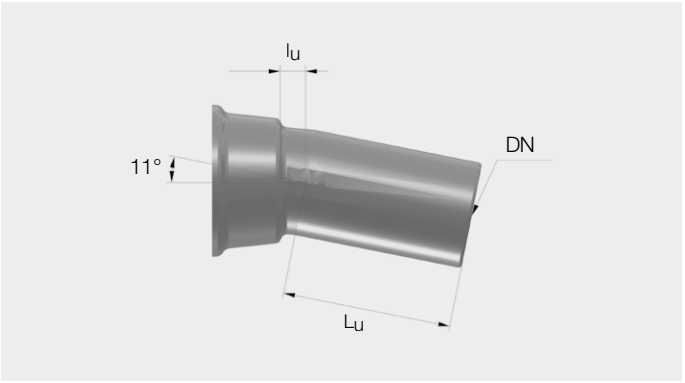


DN	l_u [mm]	L_u [mm]	PFA [bar]	Weight [kg]
80	40	248	100	7.3
100	45	253		9.2
125	50	274	64	12.7
150	55	299		16.7
200	65	331		25.5
250	75	410	50	38.8
300	85	430		52.0
400	110	855	40	120.1

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
MK FITTINGS – HYDROTIGHT
11° elbow sockets

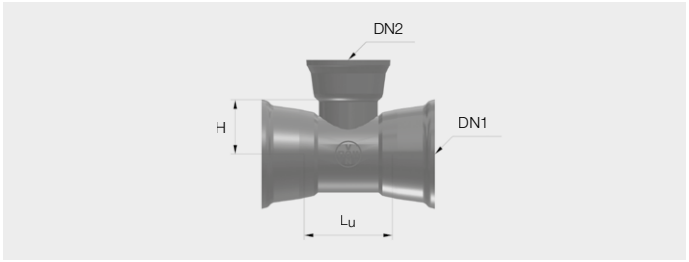


DN	l_u [mm]	L_u [mm]	PFA [bar]	Weight [kg]
80	30	240	100	7.1
100	35	243		8.8
125	35	261	64	12.1
150	40	284		15.7
200	45	311		24.0
250	50	385	50	36.2
300	55	400		47.9
400	65	815	40	111.5

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
MMB FITTINGS – HYDROTIGHT
Double socket pieces with a 90° branched socket



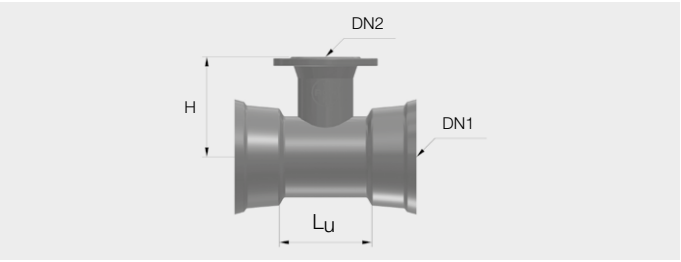
DN1	DN2	L_u [mm]	h [mm]	PFA* [bar]	Weight ~ [kg]
80	80	170	85		11.4
100	80	170	95	100	13.1
100	100	190	95		14.1
125	80	170	105		16.5
125	100	195	110		17.8
125	125	225	110		19.9
150	80	170	120		19.9
150	100	195	120		20.9
150	125	255	125	64	29.0
150	150	255	125		25.2
200	80	175	145		27.2
200	100	200	145		28.6
200	125	255	145		31.4
200	150	255	150		33.4
200	200	315	155		38.2
250	100	200	170		37.9
250	125	200	175		39.9
250	150	260	175		43.6
250	200	315	180		49.3
250	250	375	190		56.0
300	100	205	195	50	47.7
300	125	205	200		48.7
300	150	260	200		54.3
300	200	320	205		61.0
300	250	430	210		80.0
300	300	435	220		75.0
400	150	270	270		100.0
400	200	325	270		110.0
400	300	440	290	40	130.0
400	400	560	280		160.0

1) In accordance with company standard; * For reduction of the pressure application range when using VONROLL HYDROTIGHT, see page 89.

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

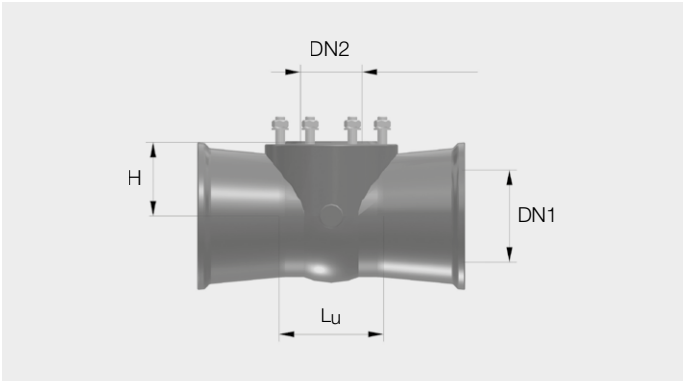
Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
MMA FITTINGS – HYDROTIGHT
Double socket pieces with a 90° flanged branch



DN1	DN2	PN*[bar]	L_u [mm]	h [mm]	Weight ~ [kg]
80	**80**	10, 16, 25, 40	170	165	12.8
125	**80**	10, 16, 25, 40	170	190	17.9
125	**100**	10, 16	195	195	19.3
125	**125**	10, 16	225	200	21.6
150	**80**	10, 16, 25, 40	170	205	21.3
150	**100**	10, 16	195	210	22.7
150	**125**	10, 16	255	220	30.0
150	**150**	10, 16	255	250	27.4
200	**80**	10, 16, 25, 40	175	235	28.6
200	**100**	10, 16	200	240	30.4
200	**125**	10, 16	255	250	32.0
200	**150**	10, 16	255	250	36.1
200	**200**	10	315	260	42.2
200	**200**	16	315	260	41.7
250	**100**	10, 16	200	270	39.7
250	**150**	10, 16	260	280	46.3
250	**200**	10	315	290	42.9
250	**200**	16	315	290	42.9
250	**250**	10	375	300	61.0
250	**250**	16	375	300	60.5
300	**100**	10, 16	205	300	50.0
300	**150**	10, 16	260	310	57,,0
300	**200**	10	320	320	65.0
300	**200**	16	320	320	65.0
300	**250**	10	430	330	74.5
300	**250**	16	430	330	74.5
300	**300**	10	435	340	83.6
300	**300**	16	435	340	83.1
350	**100**	10, 16	205	330	59,,
350	**200**	10	325	350	77.2
350	**200**	16	325	350	77.0
350	**300**	10	495	370	110.0
350	**300**	16	495	370	110.0
400	**100**	10, 16	210	360	72.0
400	**150**	10, 16	270	370	81.4
400	**200**	10	325	380	91.1
400	**200**	16	325	380	90.6
400	**250**	10	440	390	130.0
400	**250**	16	440	390	130.0
400	**300**	10	440	400	113.5
400	**300**	16	440	400	113.5
400	**400**	10	560	420	135.6
400	**400**	16	560	420	140.6

3.3 HYDROTIGHT FITTINGS
UA FITTINGS – HYDROTIGHT
Double socket pieces with block flange (push-on)



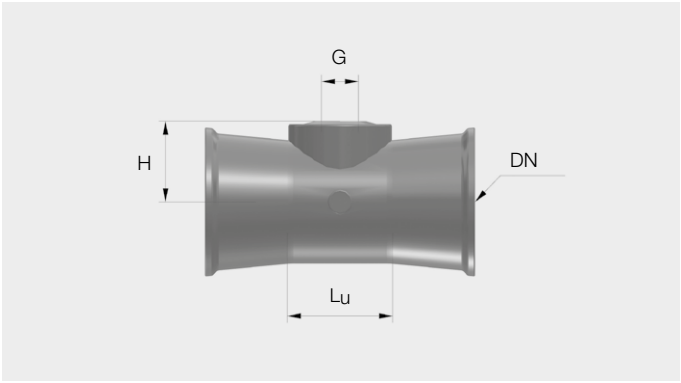
DN1	DN2	PN [bar]	L_u [mm]	h [mm]	*PFA [bar]	Weight ~ [kg]
100	**50**	10, 16, 25, 40	176	100	100	20.0
100	**100**	10, 16	176	100		23.0
125	**50**	10, 16, 25, 40	173	110	64	24.0
125	**100**	10, 16	173	110		25.0
150	**50**	10, 16, 25, 40	170	120		27.0
150	**100**	10, 16	170	120		28.0
200	**50**	10, 16, 25, 40	148	145		38.0
200	**100**	10, 16	163	145		38.0

1) In accordance with company standard; * For reduction of the pressure application range when using VONROLL HYDROTIGHT, see page 89.

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
UA FITTINGS – HYDROTIGHT
Double socket pieces with threaded connection pieces

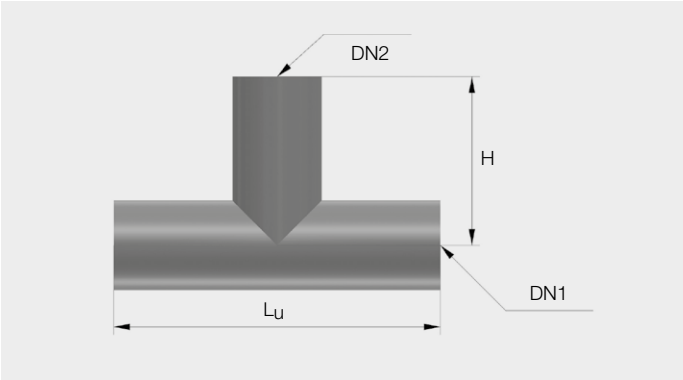


DN	G ["]	L_u [mm]	h [mm]	PFA [bar]	Weight ~ [kg]
100	2	176	100	100	15.3
125	2	173	120	64	20.0
150	2	170	130		26.0
200	2	148	160		34.0

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
IT FITTINGS – HYDROTIGHT
Head end T

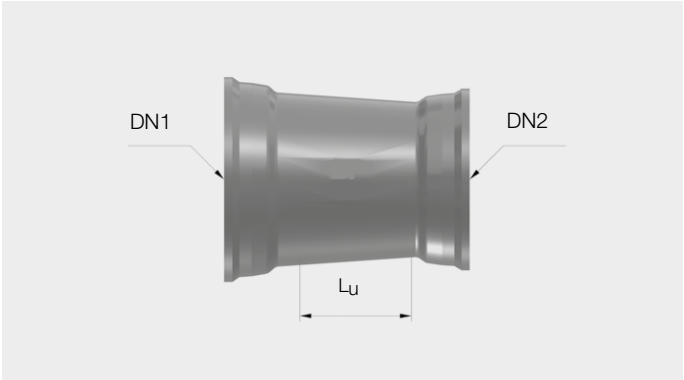


DN1	DN2	L_u [mm]	h [mm]	PFA [bar]	Weight ~ [kg]
80	**80**	540	270	100	6.5
100	**100**	550	275		14.1
150	**100**	620	320	64	23.4
150	**150**	620	320		24.3
200	**200**	650	325		35.1

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
MMR FITTINGS – HYDROTIGHT
Double socket transition pieces reduced

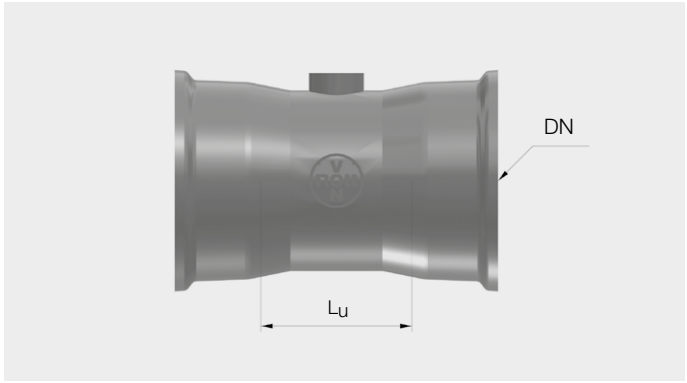


DN1	DN2	L_u [mm]	PFA [bar]	Weight ~ [kg]
100	**80**	90	100	7.5
125	**80**	140	64	9.9
125	**100**	100		9.8
150	**80**	190		12.3
150	**100**	150		12.3
150	**125**	100		12.6
200	**100**	250		18.3
200	**125**	200		18.7
200	**150**	150		18.7
250	**125**	300	50	26.3
250	**150**	250		26.5
250	**200**	150		25.8
300	**150**	350		35.9
300	**200**	250		35.7
300	**250**	150		34.6
350	**200**	360		47.8
350	**250**	260		46.8
350	**300**	180		45.1
400	**250**	360	40	66.0
400	**300**	260		64.0
400	**350**	160		55.5

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
U FITTINGS – HYDROTIGHT
Push-on sockets

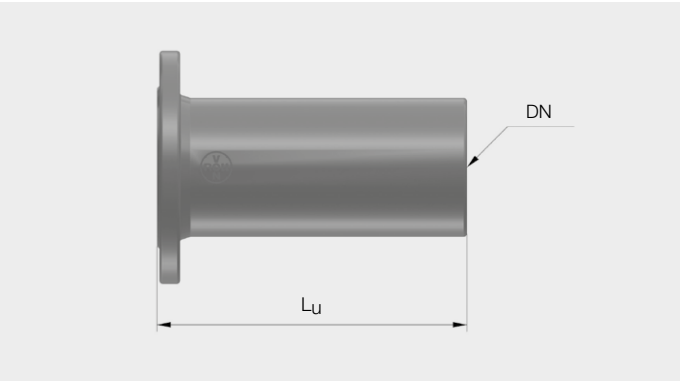


DN	PN	L_u [mm]	PFA [bar]	Weight ~ [kg]
80	16	160	100	8.9
100	16	160		10.8
125	16	165	64	13.6
150	16	165		16.7
200	16	170		23.0
250	16	175	50	31.5
300	16	180		40.5
350	16	185		51.0
400	16	190	40	62.0

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
F FITTINGS – HYDROTIGHT
Single-flange fittings

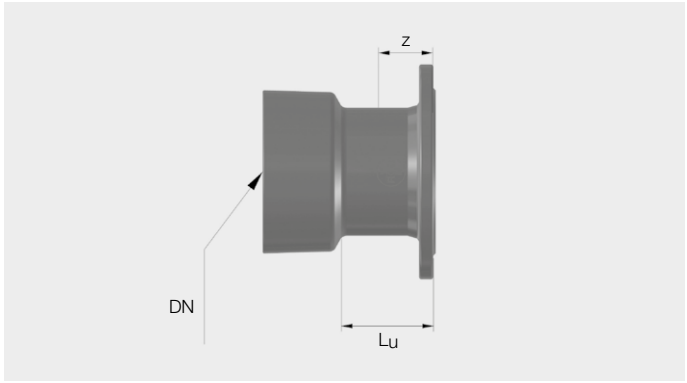


DN	PN	L_u [mm]	PFA [bar]	Weight ~ [kg]
80	10, 16, 25, 40	350	100	7.8
100	10, 16	360		9.7
100	25, 40	360		9.7
100	63	360		9.7
125	10, 16	370	64	12.5
125	25	370		12.5
125	40	370		12.5
125	63	370		12.5
150	10, 16	380		16.0
150	25	380		16.0
150	40	380		16.0
150	63	380		16.0
200	10	400		22.8
200	16	400		23.0
200	25	400		23.0
200	40	400		23.0
200	63	400		23.0
250	10	420	50	32.0
250	16	420		32.0
300	10	440		43.0
300	16	440		42.0
350	10	460		52.3
350	16	460		55.3
400	10	480	40	65.0
400	16	480		65.0

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

Seal: TYTON EPDM

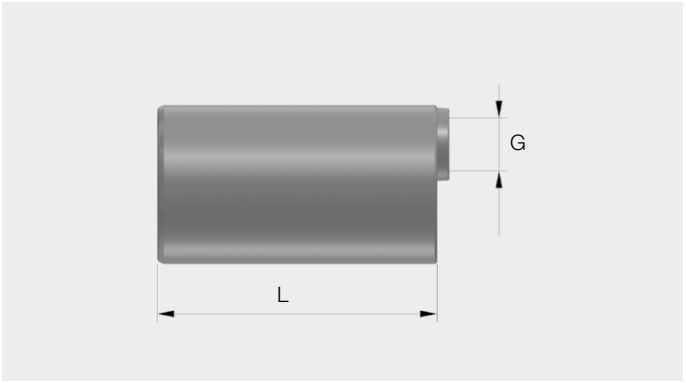
3.3 HYDROTIGHT FITTINGS
EU FITTINGS – HYDROTIGHT
Flange socket pieces



DN	PN	L_U [mm]	z [mm]	PFA [bar]	Weight ~ [kg]
80	10, 16, 25, 40	130	86 ± 40	100	9.9
100	10, 16	130	87 ± 40		9.1
100	25, 40	130	87 ± 40		10.7
125	10, 16	135	91 ± 40	64	12.4
125	25, 40	135	91 ± 40		13.2
150	10, 16	135	92 ± 40		15.2
150	25	135	92 ± 40		15.9
150	40	135	92 ± 40		18.1
200	10	140	97 ± 40		21.3
200	16	140	97 ± 40		21.8
200	25	140	97 ± 40		23.0
200	40	140	97 ± 40		26.5
250	10	145	102 ± 40	50	29.8
250	16	145	102 ± 40		29.8
250	25	145	102 ± 40		33.7
250	40	145	102 ± 40		40.7
300	10	150	107 ± 40		36.2
300	16	150	107 ± 40		36.2
350	10	155	112 ± 40		45.5
350	16	155	112 ± 40		48.5
400	10	160	117 ± 40	40	52.1
400	16	160	117 ± 40		59.0

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request
Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
P PLUG – HYDROTIGHT
Spigot end sealing cap with 2" hole

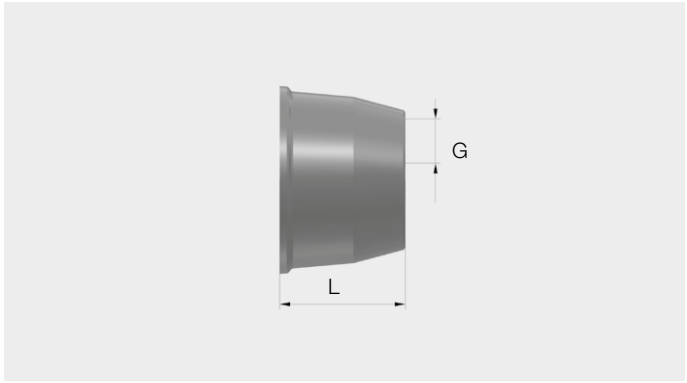


DN	L [mm]	PFA [bar]	Weight ~ [kg]
80	250	100	4.6
100	250		5.7
125	300	64	9.1
150	300		12.2
200	350		20.4
250	350	50	31.3
300	400		44.6

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request
Seal: TYTON EPDM

3.3 HYDROTIGHT FITTINGS
O FITTINGS – HYDROTIGHT

Spigot end sealing cap
with 2" hole



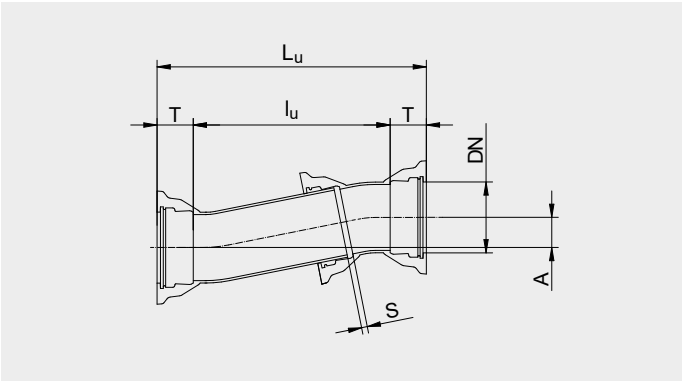
DN	L [mm]	PFA [bar]	Weight ~ [kg]
80	144	100	5.6
100	145		7.2
125	153	64	10.3
150	161		14.0
200	166		21.8
250	171	50	34.0
300	170		45.8

External/ Internal coating: thick film epoxy coating in accordance with GSK (Min. 250 µm) EN 3476 or by e-mail, on request

Seal: TYTON EPDM

3.4 Calculation of height offsets with HYDROTIGHT fittings

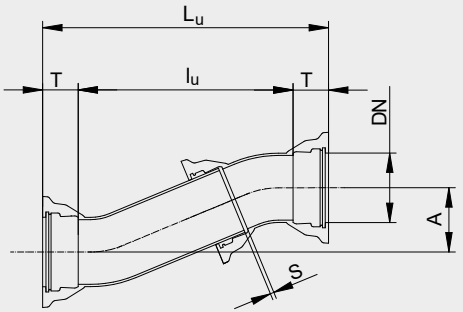
MMK + MK, 11°, DN 80 to DN 400



DN	S	A	l_u	T	L_u
80	10	55	335	84	503
100	10	56	352	88	528
125	10	60	370	91	552
150	10	65	408	94	596
200	10	71	449	100	649
250	10	87	536	105	746
300	10	92	576	110	796
400	10	174	1‘003	110	1‘223

3.4 Calculation of height offsets with HYDROTIGHT fittings

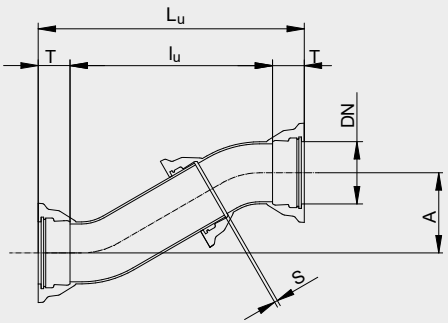
MMK + MK, 22°, DN 80 to DN 400



DN	S	A	l_u	T	L_u
80	10	114	355	84	523
100	10	118	375	88	551
125	10	128	409	91	591
150	10	139	446	94	634
200	10	155	505	100	705
250	10	189	607	105	817
300	10	203	665	110	885
400	10	373	1‘121	110	1‘341

3.4 Calculation of height offsets with HYDROTIGHT fittings

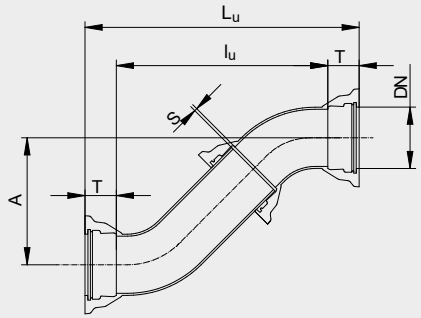
MMK + MK, 30°, DN 80 to DN 400



DN	S	A	l_u	T	L_u
80	10	154	357	84	525
100	10	160	377	88	553
125	10	174	411	91	593
150	10	192	463	94	651
200	10	218	537	100	737
250	10	268	653	105	863
300	10	285	714	110	934
400	10	523	1‘205	110	1‘425

3.4 Calculation of height offsets with HYDROTIGHT fittings

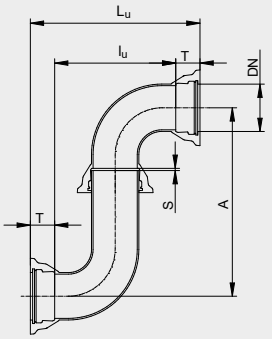
MMK + MK, 45°, DN 80 to DN 400



DN	S	A	l_u	T	L_u
80	10	233	343	84	511
100	10	247	377	88	553
125	10	273	423	91	605
150	10	301	471	94	659
200	10	349	569	100	769
250	10	428	688	105	898
300	10	470	775	110	995
400	10	810	1‘200	110	1‘420

3.4 Calculation of height offsets with HYDROTIGHT fittings

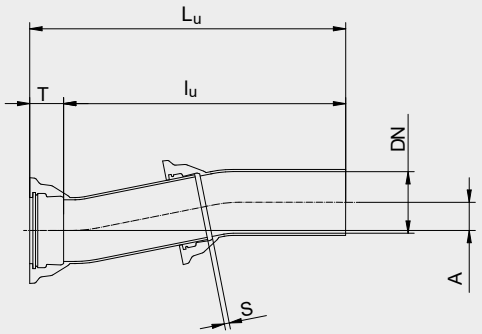
MMQ + MQ, 90°, DN 80 to DN 400



DN	S	A	l_u	T	L_u
80	10	422	200	84	368
100	10	468	250	88	426
125	10	534	300	91	482
150	10	604	350	94	538
200	10	726	450	100	650
250	10	900	550	105	760
300	10	1‘000	660	110	880
400	10	1‘605	840	110	1‘060

3.4 Calculation of height offsets with HYDROTIGHT fittings

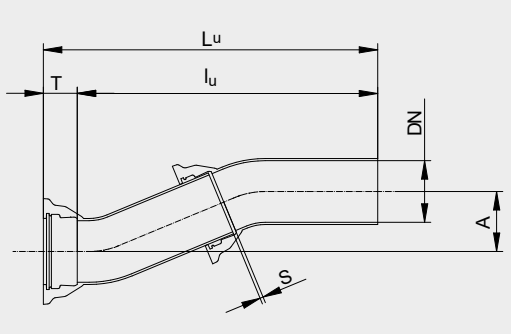
2 × MK, 11°, DN 80 to DN 400



DN	S	A	l_u	T	L_u
80	10	55	545	84	629
100	10	56	560	88	648
125	10	60	596	91	687
150	10	66	662	94	746
200	10	71	715	100	815
250	10	87	871	105	976
300	10	91	911	110	1‘021
400	10	174	1‘753	110	1‘863

3.4 Calculation of height offsets with HYDROTIGHT fittings

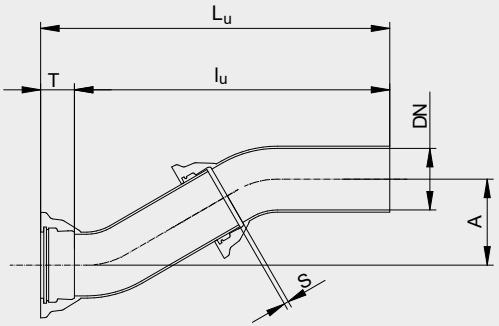
2 × MK, 22°, DN 80 to DN 400



DN	S	A	l_u	T	L_u
80	10	114	563	84	647
100	10	118	583	88	671
125	10	128	633	91	724
150	10	139	690	94	784
200	10	155	771	100	871
250	10	189	942	105	1‘047
300	10	201	1‘000	110	1‘110
400	10	373	1‘866	110	1‘976

3.4 Calculation of height offsets with HYDROTIGHT fittings

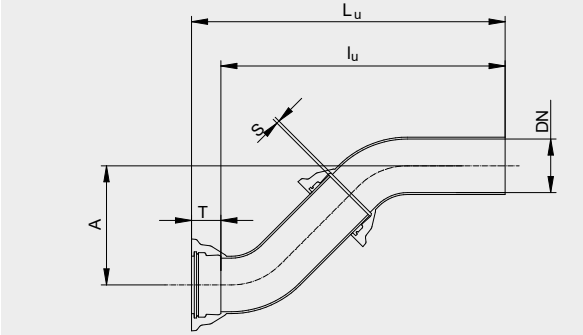
2 × MK, 30°, DN 80 to DN 400



DN	S	A	l_u	T	L_u
80	10	154	565	84	649
100	10	160	587	88	675
125	10	174	639	91	730
150	10	192	707	94	801
200	10	218	802	100	902
250	10	268	988	105	1‘093
300	10	285	1‘054	110	1‘164
400	10	523	1‘940	110	2‘050

3.4 Calculation of height offsets with HYDROTIGHT fittings

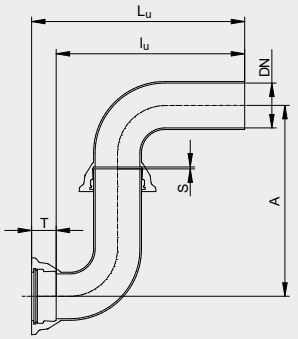
2 × MK, 45°, DN 80 to DN 400



DN	S	A	l_u	T	L_u
80	10	233	553	84	637
100	10	247	586	88	674
125	10	273	649	91	740
150	10	301	717	94	811
200	10	349	833	100	933
250	10	428	1‘023	105	1‘128
300	10	470	1‘117	110	1‘227
400	10	810	1‘945	110	2‘055

3.4 Calculation of height offsets with HYDROTIGHT fittings

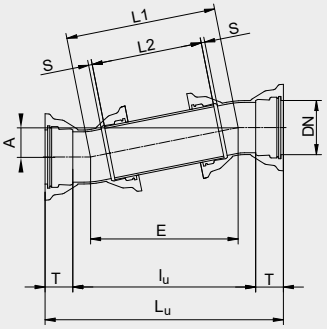
2 × MQ, 90°, DN 80 to DN 400



DN	S	A	l_u	T	L_u
80	10	422	412	84	496
100	10	468	458	88	546
125	10	534	524	91	615
150	10	604	594	94	688
200	10	726	716	100	816
250	10	890	880	105	985
300	10	1‘000	990	110	1‘100
400	10	1‘605	1‘595	110	1‘705

3.4 Calculation of height offsets with HYDROTIGHT fittings plus short pipe

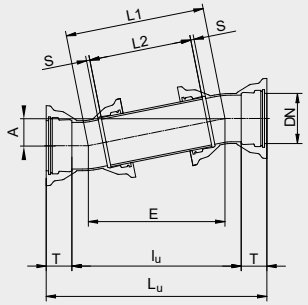
2 × MMK 11°, DN 80 to DN 400



DN	S	A	L1	L2	T	E	l_u	L_u
80	10	500	2'563	2'483	84	2'514	2'574	2'742
80	10	600	3'075	2'995	84	3'016	3'076	3'244
80	10	700	3'588	3'508	84	3'519	3'579	3'747
80	10	800	4'101	4'021	84	4'022	4'082	4'250
80	10	900	4'613	4'533	84	4'525	4'585	4'753
80	10	1'000	5'126	5'046	84	5'027	5'087	5'255
100	10	500	2'563	2'473	88	2'514	2'584	2'760
100	10	600	3'075	2'985	88	3'016	3'086	3'262
100	10	700	3'588	3'498	88	3'519	3'589	3'765
100	10	800	4'101	4'011	88	4'022	4'092	4'268
100	10	900	4'613	4'523	88	4'525	4'595	4'771
100	10	1'000	5'126	5'036	88	5'027	5'097	5'273
125	10	500	2'563	2'473	91	2'514	2'584	2'766
125	10	600	3'075	2'985	91	3'016	3'086	3'268
125	10	700	3'588	3'498	91	3'519	3'589	3'771
125	10	800	4'101	4'011	91	4'022	4'092	4'274
125	10	900	4'613	4'523	91	4'525	4'595	4'777
125	10	1'000	5'126	5'036	91	5'027	5'097	5'279
150	10	500	2'563	2'463	94	2'514	2'594	2'782
150	10	600	3'075	2'975	94	3'016	3'096	3'284
150	10	700	3'588	3'488	94	3'519	3'599	3'787
150	10	800	4'101	4'001	94	4'022	4'102	4'290
150	10	900	4'613	4'513	94	4'525	4'605	4'793
150	10	1'000	5'126	5'026	94	5'027	5'107	5'295
200	10	500	2'563	2'453	100	2'514	2'604	2'804
200	10	600	3'075	2'965	100	3'016	3'106	3'306
200	10	700	3'588	3'478	100	3'519	3'609	3'809
200	10	800	4'101	3'991	100	4'022	4'112	4'312
200	10	900	4'613	4'503	100	4'525	4'615	4'815
200	10	1'000	5'126	5'016	100	5'027	5'117	5'317

3.4 Calculation of height offsets with HYDROTIGHT fittings plus short pipe

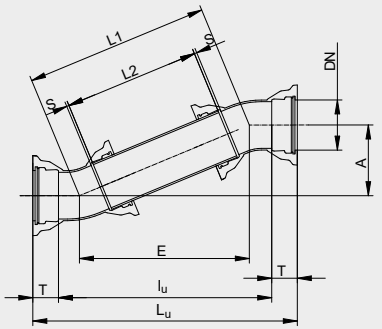
2 × MMK 11°, DN 80 to DN 400



DN	S	A	L1	L2	T	E	l_u	L_u
250	10	500	2'563	2'443	105	2'514	2'614	2'824
250	10	600	3'075	2'955	105	3'016	3'116	3'326
250	10	700	3'588	3'468	105	3'519	3'619	3'829
250	10	800	4'101	3'981	105	4'022	4'122	4'332
250	10	900	4'613	4'493	105	4'525	4'625	4'835
250	10	1'000	5'126	5'006	105	5'027	5'127	5'337
300	10	500	2'563	2'423	110	2'514	2'634	2'854
300	10	600	3'075	2'935	110	3'016	3'136	3'356
300	10	700	3'588	3'448	110	3'519	3'639	3'859
300	10	800	4'101	3'961	110	4'022	4'142	4'362
300	10	900	4'613	4'473	110	4'525	4'645	4'865
300	10	1'000	5'126	4'986	110	5'027	5'147	5'367
350	10	500	2'563	2'413	110	2'514	2'644	2'864
350	10	600	3'075	2'925	110	3'016	3'146	3'366
350	10	700	3'588	3'438	110	3'519	3'649	3'869
350	10	800	4'101	3'951	110	4'022	4'152	4'372
350	10	900	4'613	4'463	110	4'525	4'655	4'875
350	10	1'000	5'126	4'976	110	5'027	5'157	5'377
400	10	500	2'563	2'413	110	2'514	2'644	2'864
400	10	600	3'075	2'925	110	3'016	3'146	3'366
400	10	700	3'588	3'438	110	3'519	3'649	3'869
400	10	800	4'101	3'951	110	4'022	4'152	4'372
400	10	900	4'613	4'463	110	4'525	4'655	4'875
400	10	1'000	5'126	4'976	110	5'027	5'157	5'377

3.4 Calculation of height offsets with HYDROTIGHT fittings plus short pipe

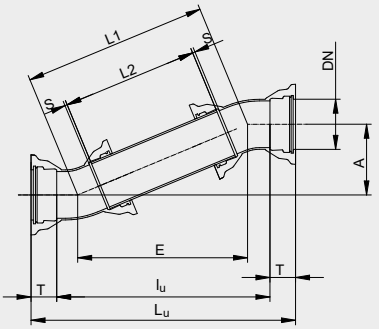
2 × MMK 22°, DN 80 to DN 400



DN	S	A	L1	L2	T	E	l_u	L_u
80	10	500	1'307	1'207	84	1'207	1'287	1'455
80	10	600	1'568	1'468	84	1'449	1'529	1'697
80	10	700	1'829	1'729	84	1'690	1'770	1'938
80	10	800	2'091	1'991	84	1'931	2'011	2'179
80	10	900	2'352	2'252	84	2'173	2'253	2'421
80	10	1'000	2'613	2'513	84	2'414	2'494	2'662
100	10	500	1'307	1'197	88	1'207	1'297	1'473
100	10	600	1'568	1'458	88	1'449	1'539	1'715
100	10	700	1'829	1'719	88	1'690	1'780	1'956
100	10	800	2'091	1'981	88	1'931	2'021	2'197
100	10	900	2'352	2'242	88	2'173	2'263	2'439
100	10	1'000	2'613	2'503	88	2'414	2'504	2'680
125	10	500	1'307	1'187	91	1'207	1'307	1'489
125	10	600	1'568	1'448	91	1'449	1'549	1'731
125	10	700	1'829	1'709	91	1'690	1'790	1'972
125	10	800	2'091	1'971	91	1'931	2'031	2'213
125	10	900	2'352	2'232	91	2'173	2'273	2'455
125	10	1'000	2'613	2'493	91	2'414	2'514	1'696
150	10	500	1'307	1'177	94	1'207	1'317	1'505
150	10	600	1'568	1'438	94	1'449	1'559	1'747
150	10	700	1'829	1'699	94	1'690	1'800	1'988
150	10	800	2'091	1'961	94	1'931	2'041	2'229
150	10	900	2'352	2'222	94	2'173	2'283	2'471
150	10	1'000	2'613	2'483	94	2'414	2'524	2'715
200	10	500	1'307	1'157	100	1'207	1'337	1'537
200	10	600	1'568	1'418	100	1'449	1'579	1'779
200	10	700	1'829	1'679	100	1'690	1'820	2'020
200	10	800	2'091	1'941	100	1'931	2'061	2'261
200	10	900	2'352	2'202	100	2'173	2'303	2'503
200	10	1'000	2'613	2'463	100	2'414	2'544	2'744
250	10	500	1'307	1'137	105	1'207	1'357	1'567
250	10	600	1'568	1'398	105	1'449	1'599	1'809
250	10	700	1'829	1'659	105	1'690	1'840	2'050
250	10	800	2'091	1'921	105	1'931	2'081	2'291
250	10	900	2'352	2'182	105	2'173	2'323	2'533
250	10	1'000	2'613	2'443	105	2'414	2'564	2'774

3.4 Calculation of height offsets with HYDROTIGHT fittings plus short pipe

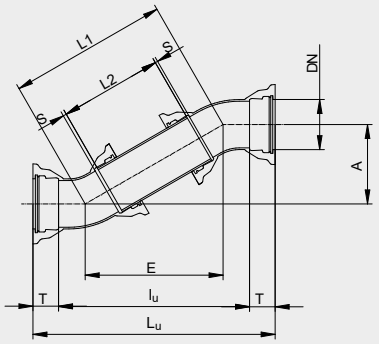
2 × MMK 22°, DN 80 to DN 400



DN	S	A	L1	L2	T	E	l_u	L_u
300	10	500	1'307	1'107	110	1'207	1'387	1'607
300	10	600	1'568	1'368	110	1'449	1'629	1'849
300	10	700	1'829	1'629	110	1'690	1'870	2'090
300	10	800	2'091	1'891	110	1'931	2'111	2'331
300	10	900	2'352	2'152	110	2'173	2'353	2'573
300	10	1'000	2'613	2'413	110	2'414	2'594	2'814
350	10	500	1'307	1'087	110	1'207	1'407	1'627
350	10	600	1'568	1'348	110	1'449	1'649	1'869
350	10	700	1'829	1'609	110	1'690	1'890	2'110
350	10	800	2'091	1'871	110	1'931	2'131	2'351
350	10	900	2'352	2'132	110	2'173	2'373	2'593
350	10	1'000	2'613	2'393	110	2'414	2'614	2'834
400	10	500	1'307	1'067	110	1'207	1'427	1'647
400	10	600	1'568	1'328	110	1'449	1'669	1'889
400	10	700	1'829	1'589	110	1'690	1'910	2'130
400	10	800	2'091	1'851	110	1'931	2'151	2'371
400	10	900	2'352	2'112	110	2'173	2'393	2'613
400	10	1'000	2'613	2'373	110	2'414	2'634	2'854

3.4 Calculation of height offsets with HYDROTIGHT fittings plus short pipe

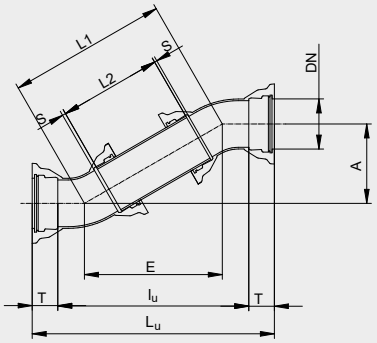
2 × MMK 30°, DN 80 to DN 400



DN	S	A	L1	L2	T	E	l_u	L_u
80	10	500	1'000	890	84	866	956	1'124
80	10	600	1'200	1'090	84	1'039	1'129	1'297
80	10	700	1'400	1'290	84	1'212	1'302	1'470
80	10	800	1'600	1'490	84	1'386	1'476	1'644
80	10	900	1'800	1'690	84	1'559	1'649	1'817
80	10	1'000	2'000	1'890	84	1'732	1'822	1'990
100	10	500	1'000	880	88	866	966	1'142
100	10	600	1'200	1'080	88	1'039	1'139	1'315
100	10	700	1'400	1'280	88	1'212	1'312	1'488
100	10	800	1'600	1'480	88	1'386	1'486	1'662
100	10	900	1'800	1'680	88	1'559	1'659	1'835
100	10	1'000	2'000	1'880	88	1'732	1'832	2'008
125	10	500	1'000	870	91	866	976	1'158
125	10	600	1'200	1'070	91	1'039	1'149	1'331
125	10	700	1'400	1'270	91	1'212	1'322	1'504
125	10	800	1'600	1'470	91	1'386	1'496	1'678
125	10	900	1'800	1'670	91	1'559	1'669	1'851
125	10	1'000	2'000	1'870	91	1'732	1'842	2'024
150	10	500	1'000	850	94	866	996	1'184
150	10	600	1'200	1'050	94	1'039	1'169	1'357
150	10	700	1'400	1'250	94	1'212	1'342	1'530
150	10	800	1'600	1'450	94	1'386	1'516	1'704
150	10	900	1'800	1'650	94	1'559	1'689	1'877
150	10	1'000	2'000	1'850	94	1'732	1'862	2'050
200	10	500	1'000	820	100	866	1'026	1'226
200	10	600	1'200	1'020	100	1'039	1'199	1'399
200	10	700	1'400	1'220	100	1'212	1'372	1'572
200	10	800	1'600	1'420	100	1'386	1'546	1'746
200	10	900	1'800	1'620	100	1'559	1'719	1'919
200	10	1'000	2'000	1'820	100	1'732	1'892	2'092
250	10	500	1'000	790	105	866	1'056	1'266
250	10	600	1'200	990	105	1'039	1'229	1'439
250	10	700	1'400	1'190	105	1'212	1'402	1'612
250	10	800	1'600	1'390	105	1'386	1'576	1'786
250	10	900	1'800	1'590	105	1'559	1'749	1'959
250	10	1'000	2'000	1'790	105	1'732	1'922	2'132

3.4 Calculation of height offsets with HYDROTIGHT fittings plus short pipe

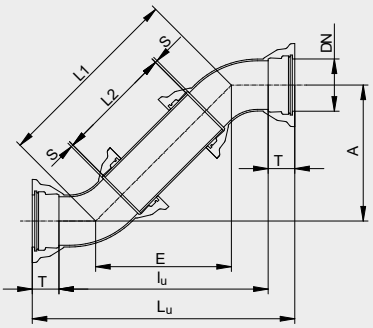
2 × MMK 30°, DN 80 to DN 400



DN	S	A	L1	L2	T	E	l_u	L_u
300	10	500	1'000	760	110	866	1'086	1'306
300	10	600	1'200	960	110	1'039	1'259	1'479
300	10	700	1'400	1'160	110	1'212	1'432	1'652
300	10	800	1'600	1'360	110	1'386	1'606	1'826
300	10	900	1'800	1'560	110	1'559	1'779	1'999
300	10	1'000	2'000	1'760	110	1'732	1'952	2'172
350	10	500	1'000	730	110	866	1'116	1'336
350	10	600	1'200	930	110	1'039	1'289	1'509
350	10	700	1'400	1'130	110	1'212	1'462	1'682
350	10	800	1'600	1'330	110	1'386	1'636	1'856
350	10	900	1'800	1'530	110	1'559	1'809	2'029
350	10	1'000	2'000	1'730	110	1'732	1'982	2'202
400	10	500	1'000	680	110	866	1'166	1'386
400	10	600	1'200	880	110	1'039	1'339	1'559
400	10	700	1'400	1'080	110	1'212	1'512	1'732
400	10	800	1'600	1'280	110	1'386	1'686	1'906
400	10	900	1'800	1'480	110	1'559	1'859	2'079
400	10	1'000	2'000	1'680	110	1'732	2'032	2'252

3.4 Calculation of height offsets with HYDROTIGHT fittings plus short pipe

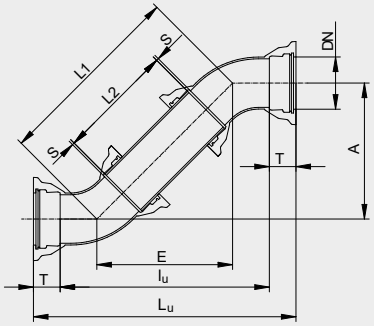
2 × MMK 45°, DN 80 to DN 400



DN	S	A	L1	L2	T	E	l_u	L_u
80	10	500	707	577	84	500	610	778
80	10	600	849	719	84	600	710	878
80	10	700	990	860	84	700	810	978
80	10	800	1'131	1'001	84	800	910	1'078
80	10	900	1'273	1'143	84	900	1'010	1'178
80	10	1'000	1'414	1'284	84	1'000	1'110	1'278
100	10	500	707	557	88	500	630	806
100	10	600	849	699	88	600	730	906
100	10	700	990	840	88	700	830	1'006
100	10	800	1'131	981	88	800	930	1'106
100	10	900	1'273	1'123	88	900	1'030	1'206
100	10	1'000	1'414	1'264	88	1'000	1'130	1'306
125	10	500	707	537	91	500	650	832
125	10	600	849	679	91	600	750	932
125	10	700	990	820	91	700	850	1'032
125	10	800	1'131	961	91	800	950	1'132
125	10	900	1'273	1'103	91	900	1'050	1'232
125	10	1'000	1'414	1'244	91	1'000	1'150	1'332
150	10	500	707	517	94	500	670	858
150	10	600	849	659	94	600	770	958
150	10	700	990	800	94	700	870	1'058
150	10	800	1'131	941	94	800	970	1'158
150	10	900	1'273	1'083	94	900	1'070	1'258
150	10	1'000	1'414	1'224	94	1'000	1'170	1'358
200	10	500	707	467	100	500	720	920
200	10	600	849	609	100	600	820	1'020
200	10	700	990	750	100	700	920	1'120
200	10	800	1'131	891	100	800	1'020	1'220
200	10	900	1'273	1'033	100	900	1'120	1'320
200	10	1'000	1'414	1'174	100	1'000	1'220	1'420
250	10	500	707	427	105	500	760	970
250	10	600	849	569	105	600	860	1'070
250	10	700	990	710	105	700	960	1'170
250	10	800	1'131	851	105	800	1'060	1'270
250	10	900	1'273	993	105	900	1'160	1'370
250	10	1'000	1'414	1'134	105	1'000	1'260	1'470

3.4 Calculation of height offsets with HYDROTIGHT fittings plus short pipe

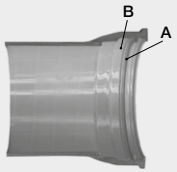
2 × MMK 45°, DN 80 to DN 400



DN	S	A	L1	L2	T	E	l_u	L_u
300	10	500	707	377	110	500	810	1'030
300	10	600	849	519	110	600	910	1'130
300	10	700	990	660	110	700	1'010	1'230
300	10	800	1'131	801	110	800	1'110	1'330
300	10	900	1'273	943	110	900	1'210	1'430
300	10	1'000	1'414	1'084	110	1'000	1'310	1'530
350	10	500	707	337	110	500	850	1'070
350	10	600	849	479	110	600	950	1'170
350	10	700	990	620	110	700	1'050	1'270
350	10	800	1'131	761	110	800	1'150	1'370
350	10	900	1'273	903	110	900	1'250	1'470
350	10	1'000	1'414	1'044	110	1'000	1'350	1'570
400	10	500	707	297	110	500	890	1'110
400	10	600	849	439	110	600	990	1'210
400	10	700	990	580	110	700	1'090	1'310
400	10	800	1'131	721	110	800	1'190	1'410
400	10	900	1'273	863	110	900	1'290	1'510
400	10	1'000	1'414	1'004	110	1'000	1'390	1'610

3.5 HYDROTIGHT fitting instructions for push-in socket pipes from DN 80 to DN 400

With internal joint restraint



Double-chamber socket

1) General information

Observing the instructions will guarantee that the pipes are fitted correctly and without faults.

2) Cleaning the push-in sockets

Check that the inner part of the push-in sockets is clean in the area around the retaining groove and the spigot end.

(A) Do not lubricate the retaining groove
(B) Apply a small amount of lubricant to the sealing chamber

3) Inserting the EPDM TYTON sealing ring

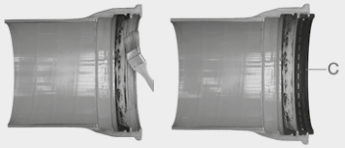
- The sealing ring must always be inserted.
- The sealing ring is inserted by hand by forming it into a loop.
- Press the remaining part of the loop down flat.
- If it is difficult to press the loop down flat, form a second loop opposite it. The two small loops can easily be pressed flat.

Notes

- Sealing rings must be stored in a place which is protected from sunlight and moisture.
- They must only be inserted into the push-in sockets immediately before fitting.
- In winter, it is advantageous to store the sealing rings in a warm place, as this makes it easier to fit them.

3.5 HYDROTIGHT fitting instructions for push-in socket pipes from DN 80 to DN 400

With internal joint restraint

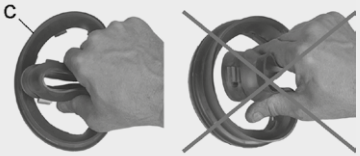


The inner hard rubber edge of the sealing ring must not stick out over the centring collar.

4) Lubricating the spigot ends of the pipes, fittings and socket

- Lubricate the thrust-resistance chamber with sufficient lubricant.
- Form the thrust-resistance ring (C) into a loop in the centre with one simple hand movement.
- Insert the thrust-resistance ring (C) into the thrust-resistance chamber.

Fit the rubber lip so that it faces outwards.



5) Checking for correct installation

- You must be able to turn the joint restraint in the chamber by hand.
- The thrust-resistance ring is coated evenly all round with lubricant.

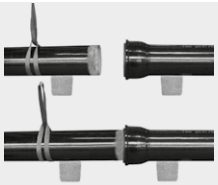
3.5 HYDROTIGHT fitting instructions for push-in socket pipes from DN 80 to DN 400

With internal joint restraint

*** For fittings with a single-chamber socket, the external joint restraint must be used** (see pre-fitted thrust-resistance chamber).

6) Centring and aligning the push-in socket joint

- Insert the pipe into the socket with the spigot end so that it is centred on the thrust-resistance ring.
- The horizontal and vertical axes of the pipe elements to be fitted (pipes, fittings, valves) must form a straight line.



7) Fitting

During and after fitting, the depth of insertion must be monitored. See point 8. Fitting with the installation device for pipes and fittings from DN 80 to DN 350.

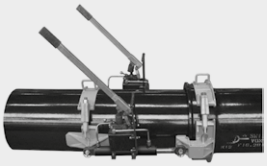
1) After centring, the pipeline components are quickly and conveniently joined together using the installation device. The device is operated using the open-end wrenches.

Please note:

When fitting a push-in socket joint with internal joint restraint, it is locked in place using two to three sharp movements on the open-end wrenches in the opposite direction.

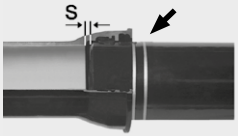
3.5 HYDROTIGHT fitting instructions for push-in socket pipes from DN 80 to DN 400

With internal joint restraint



Fitting with the installation device for pipes and fittings from DN 300 to 400

The installation device is hydraulically operated and is designed for joining push-in sockets. For installation with internal joint restraint, locking is achieved by changing the pulling direction on the valve levers and moving back with the hydraulic unit.



Without joint restraint

8) Checks during and after fitting

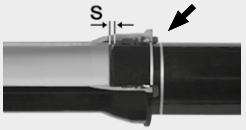
The clearance between the pipe spigot end and the base of the socket must be within the tolerance of (S) = 5–10 mm.
Push-in socket joints with double chamber socket
DN 80 to DN 400 (pipes)

Position of the marking line for push-in socket joints

Without joint restraint
If the edge of the pipe socket is flush with the first marking line, the pipe spigot end is positioned correctly in the socket.

3.5 HYDROTIGHT fitting instructions for push-in socket pipes from DN 80 to DN 400

With internal joint restraint



With internal joint restraint

If the edge of the rubber sleeve of the thrust-resistance ring is flush with the second marking line, the pipe spigot end is positioned correctly in the socket.

9) Displacement of the joint when fitting with/without internal joint restraint

After the fitting and checking processes are complete, the pipes may be displaced. The permitted displacement angle α is:

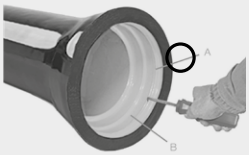
Without joint restraint	*With joint restraint*
≤ 5° for DN 80 to DN 300	≤ 3° for DN 80 to DN 400
≤ 4° for DN 350 to DN 400	

10) Removing the push-in socket joint

When removing the push-in socket joint, it must be determined whether it should be removed with or without joint restraint.
Removing the push-in socket joint without joint restraint
Using the installation device
Pull the spigot end out of the socket with open-end wrenches.

3.5 HYDROTIGHT fitting instructions for push-in socket pipes from DN 80 to DN 400

With pre-fitted joint restraint



1) General information

Observing the instructions will guarantee that the pipes are fitted correctly and without faults.

Components

1 × thrust-resistance ring, blue
1 × locking ring with steel segments
4 × head bolts and nut (galv. 5.6 or stainless steel V2A)

2) Cleaning the push-in sockets

Check that the inner part of the push-in sockets is clean in the area around the retaining groove and the spigot end. (A) Do not lubricate the retaining groove (B) Apply a small amount of lubricant to the sealing chamber.

3) Inserting the TYTON EPDM sealing ring

- The sealing ring must always be inserted.
- The sealing ring is inserted by hand by forming it into a loop.
- Press the remaining part of the loop down flat.
- If it is difficult to press the loop down flat, form a second loop opposite it. The two small loops can easily be pressed flat.

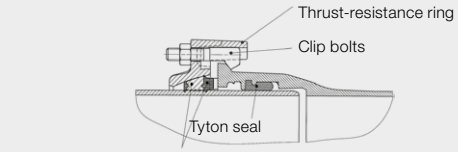
Note

- Sealing rings must be stored in a place which is protected from sunlight and moisture.
- They must only be inserted into the push-in sockets immediately before fitting.
- In winter, it is advantageous to store the sealing rings in a warm place, as this makes it easier to fit them.

The inner hard rubber edge of the sealing ring must not stick out over the centring collar.

3.5 HYDROTIGHT fitting instructions for push-in socket pipes from DN 80 to DN 400

With pre-fitted joint restraint



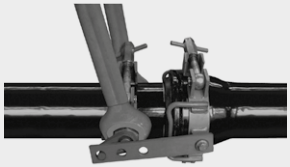
4) Lubricating the spigot ends of the pipes, fittings and socket

Fitting

1) Push the thrust-resistance ring and locking ring with steel segments onto the spigot end of the pipe or fitting
2) Insert with the installation device
3) Move the locking ring against the edge of the socket
4) Tighten the head bolts and nut crosswise to 120 Nm using a torque wrench, similarly to the flange joint.

Note: The clip bolts must be centred.

3.6 HYDROTIGHT disassembly instructions for push-in socket pipes from DN 80 to DN 40



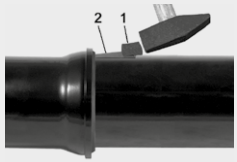
5) Removing the push-in socket joint without joint restraint.

– Using the installation device.
– Push the spigot end out of the socket with open-end wrenches.

Disassembly of the push-in socket joint with internal joint restraint
– Using the installation device, pull the pipe spigot end in until it comes into contact with the base of the socket. (Unlocking)
– Drive the disassembly plates between the pipe spigot end and locking ring all the way round using the drive heads.

Need for disassembly plates

DN	Quantity
80	4
100	5
125	6
150	7
200	9
250	12
300	15
350	16
400	17



The joint is released with the installation device (similar to "Removal without joint restraint").

Removed joint restraints and seals must not be reused.

3.7 Shortening HYDROTIGHT pipes for push-in socket pipes from DN 80 to DN 40

11) Cutting pipes to length
The regulations to ensure accident prevention must be observed in accordance with the instructions of the device manufacturer. Use appropriate protective clothing and equipment when carrying out the work.

Marking the separating point
Separating cut at right angles to the pipe axis. Before separating, the cutting path must be marked around the entire circumference of the pipe.

Equipment
Wrap as wide as possible a parallel steel strip around the pipe shaft, and mark along the edge.

Marking lines for shortened pipes
The marking lines must be transferred to the spigot end of the short pipe in accordance with the pipework element to be installed.

Single-chamber fittings		Pipes, gate valves and UNI-T with double chamber			
		With internal joint restraint		Without internal joint restraint	
DN	**L mm**	**DN**	**L mm**	**DN**	**L mm**
80	80	80	126	80	109
100	82	100	127	100	110
125	85	125	130	125	113
150	88	150	133	150	116
200	94	200	138	200	121
250	94	250	138	250	121
300	95	300	137	300	120
350	98	350	142	350	125
400	100	400	149	400	135

3.7 Shortening HYDROTIGHT pipes

Separating
Suitable tool for cutting, e.g. cutting machine

Rounding off the separating edge
Round off the spigot end of the separated pipe.
Suitable device for rounding off: Hand grinder.

Version
The radius (R) is decisive, as with the supplied pipe with push-in socket of DN 80 to DN 150 R 5 mm / DN 350 to DN 400 R 7 mm / DN 200 to DN 300 R 6 mm. Sharp edges must be sufficiently rounded off. They make insertion more difficult and pose a risk of damage to the sealing rings. Sharp edges can lead to incorrect insertion.

Under no circumstances may the PUR coating be peeled off/removed further than the smoothing.

Protect DUCPUR/CEMPUR with a coating suitable for drinking water.
ECOPUR and ECOCEM pipes with a 2-component suitable repair kit to achieve full protection.

3.8 Repair of damaged PUR coating

Repair of damaged PUR coating
RESICOAT® RS repair set or equivalent

1) Operating instructions
RESICOAT® RS is a ready-to-use packaged two-component repair material in the correct mixing ratio of 2:1. User-friendly filling into a two-chamber cartridge allows the immediate repair of defects on pipes with PUR coatings.

2) Area of application
For the repair of defects caused by retaining tools during coating and of bare spots after sawing, drilling or milling. Repair of mechanical damage caused during transport and installation.

3) Handling
User-friendly filling into double-chamber cartridges enables perfect dosing of the resin hardener components in a ratio of 2:1.

4) Cartridge and gun
A mixing tube is used here to homogenise the two components.

5) Processing note
The substrate must be dry and free of oil, grease and oxidation. The temperature must be at least 3 °C above the dew point of the surrounding air. The mixing temperature is 5 °C. Ensure that both components are coming out of both sides before fitting the mixing tube. Discard the first approx. 3 ml.

6) Hardening

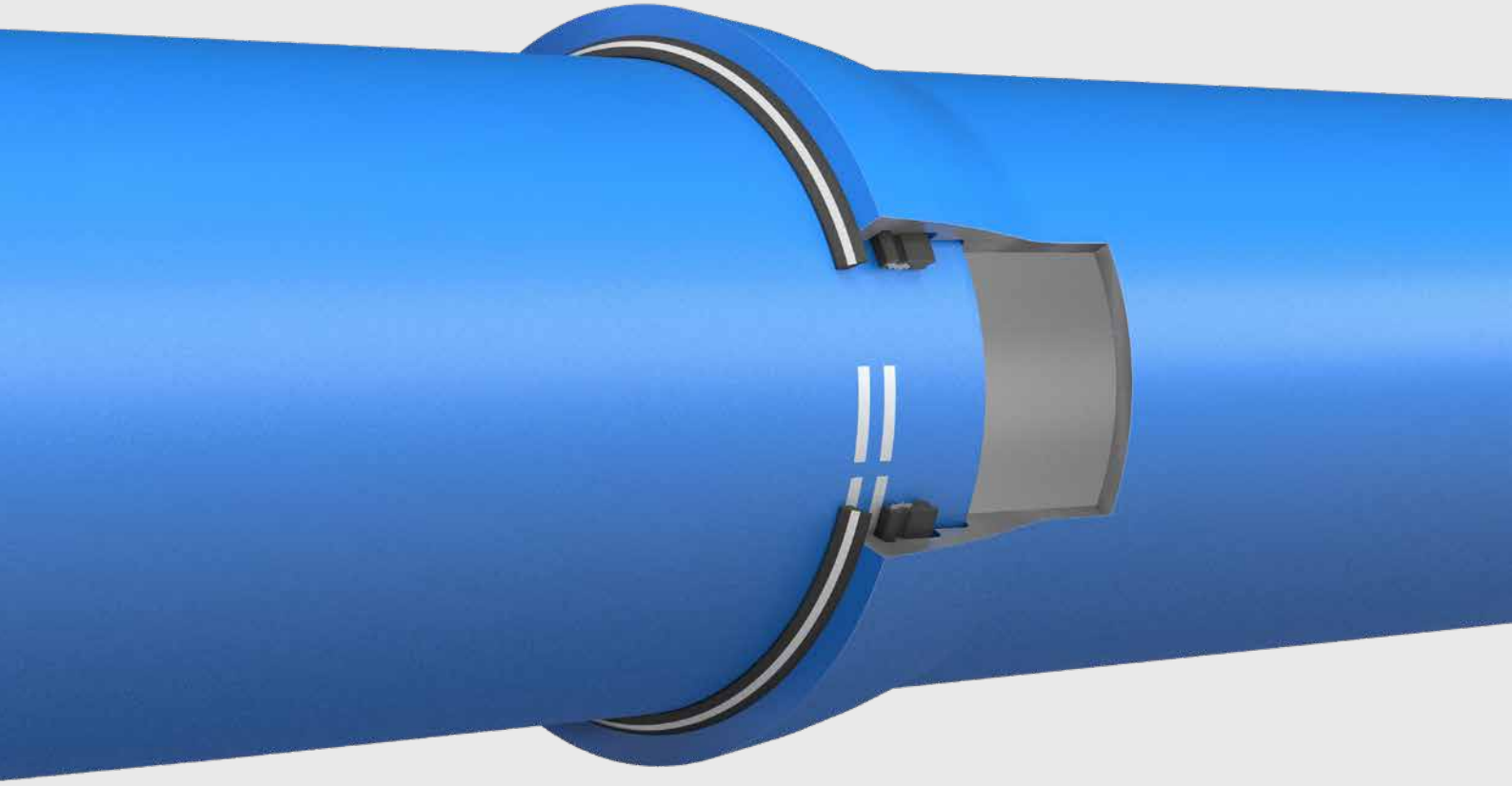
Pot life (23 °C):	15 minutes
Dust-dry (23 °C):	Approx. two hours
Hardening (23 °C):	24 hours

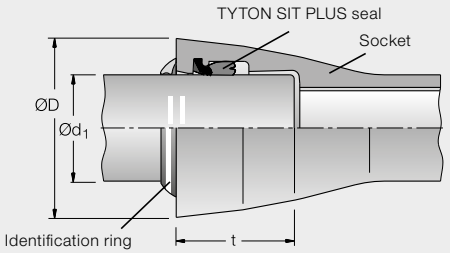
7) Drinking water contact
Appropriate test certificates are available for contact with drinking water.

4

BRS FRICTIONAL LOCKING SYSTEM TECHNOLOGY

Pipes, fittings and installation instructions





BRS (also known as TYTON SIT PLUS) is available in nominal sizes DN 80 to DN 600 for pipes and fittings. This joint is based on the TYTON joint. The frictional locking BRS system is created by replacing the TYTON sealing ring with a TYTON SIT PLUS seal.

Applications/benefits
Pipes and fittings with frictional locking joints are primarily designed for conventional installation in an open trench. Frictional locking joints, such as BRS, are not suitable for trenchless installation procedures in accordance with DVGW worksheets GW 320-1 to GW 324.

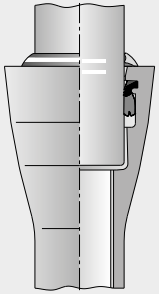
While abutments or fixed points (e.g. in accordance with DVGW GW 310) must be provided at elbows, branches, reducers, etc. for non-longitudinal positive locking systems, this is not necessary for the frictional locking BRS system. The stretch of pipeline to be protected must be designed in accordance with DVGW GW 368, or the entire installation must use the BRS system. The replacement or elimination of abutments or fixed points is the basic area of application for frictional locking joint systems. An estimated design of abutments or fixed points and pipe lengths to be secured is dealt with in Chapter 9.3, page 330 et seq.

PFA – permissible component operating pressure
Ductile cast-iron pipes with non-longitudinal positive locking push-in socket joints (e.g. TYTON) are categorised into pressure classes in accordance with EN 545. These pressure classes are also designated as C classes. The maximum PFA of a pipe corresponds to its pressure class (e.g. C 50 = PFA 50 bar). This applies exclusively to pipes without longitudinal positive locking. If the same pipe is designed with longitudinal positive locking, for example using a TYTON SIT PLUS seal, the permissible PFA is reduced.

Example: DN 200 to C 50
This pipe has a permissible PFA of 50 bar when designed without longitudinal positive locking. When using a TYTON SIT PLUS seal, the PFA is reduced to 16 bar. For the permissible PFA for our BRS joint, depending on C class and nominal size.

PMA = 1.2 × PFA (highest permissible component operating pressure for a short time, e.g. pressure surge).

PEA = 1.2 × PFA + 5 (highest permissible component test pressure on the construction site).



Before using non-positive locking joints in culvert pipes, bridge pipelines and exposed pipes, as well as before installation on steep slopes, in protective pipes and collectors or under unstable ground conditions, our Application Technology department should always be consulted.

The BRS joint is not suitable for trenchless installation procedures.

DN	Maximum PFA [bar]	Maximum deflection [°]	Weight of seal [kg]
80	32	3	0.15
100	32		0.17
125	25		0.20
150	25		0.24
200	25		0.41
250	25		0.56
300	25		0.93
350	25		1.15
400	16	2	1.44
500	16		2.20
600	10		2.93

PFA: Permissible component operating pressure in bar, may be lower depending on pressure class
PMA = 1.2 × PFA; PEA = 1.2 × PFA + 5

4.2 BRS PIPES
DN 80 to DN 600
According to EN 545:2010

4.2 BRS PIPES
DN 80 to DN 600
According to EN 545:2010

External coatings
Zinc coating with cement mortar coating (ZMU)
Zinc coating with finishing layer (ZIPOX)
Zinc-aluminium coating with finishing layer ZIPOX+, (DUCPUR to DN 700)
WKG coating

Internal coatings
Polyurethane
Cement mortar lining based on aluminous cement
Cement mortar lining based on blast furnace cement

DN	d1 [mm]	C 40 (6 m) S1	C 40 (6 m) Weight [kg]	C 40 (6 m) PFA BRS	C 50 (6 m) S1	C 50 (6 m) Weight [kg]	C 50 (6 m) PFA BRS	C 64 (6 m) S1	C 64 (6 m) Weight [kg]	C 64 (6 m) PFA BRS	C 100 (6 m) S1	C 100 (6 m) Weight [kg]	C 100 (6 m) PFA BRS	Weight ZMU** [kg]	PUR weight * [kg]	s2	s3
80	98 +1/-2.7				3.5	79.1	16				4.7 3)	94.0	32	19.5	5.4/3.8	4	5
100	118 +1/-2.8				3.5	98.7	16				4.7 3)	118.4	32	24.0	5.7/4.5	4	5
125	144 +1/-2.8				3.5	125.2	16	4.8 3)	150.4	25	5.0	155.5	25	28.0	6.9/5.7	4	5
150	170 +1/-2.9				3.7 1)	154.3	16	4.7 2) 5.0 3)	175.4 183.8	25	5.9	205.8	25	33.0	8.4/6.4	4	5
200	222 +1/-3.0				3.9	209.1	16	5.0 2) 5.5 3)	245.4 259.2	25	7.7	323.1	25	43.0	12.3/8.1	4	5
250	274 +1/-3.1	4.2 1)	272.9	16	5.2 2)	316.3	25	6.1	347.4	25	9.5	468.1	25	52.0	15.5/9.9	4	5
300	326 +1/-3.3	4.6	351.8	16	5.7 2)	410.0	25	7.3	475.8	25				63.0	18.4/11.6	4	5
350	378 +1/-3.4	6.0 2)	496.0	25	6.6	524.8	25	8.5	615.6	25				72.0	20.4/13.3	5	5
400	429 +1/-3.5	6.4 2)	601.3	16	7.5	661.5	16	9.6	775.4	16				82.0	23.3/14.9	5	5
500	532 +1/-3.8	7.5	837.4	16	9.3	959.7	16							101.0	29.1/18.1	5	5
600	635 +1/-4.0	8.9	1162.0	10										121.0	35.0/21.2	5	5

1) C 40 in accordance with EN 545:2006; 2) K9 in accordance with EN 545:2006; 3) K10 in accordance with EN 545:2006; s1) Minimum wall thickness in mm;
s2) Nominal value of the cement mortar lining layer thickness in mm;
s3) Nominal value of the zinc-aluminium coating and epoxy resin finishing layer, weight of cement mortar coating = additional weight of the cement mortar coating in kg;
installation length Lu = 6 m and 5 m. Special lengths on request

PFA: Maximum permissible component operating pressure in bar. PMA = 1.2 x PFA. PEA = 1.2 x PFA + 5.
The PFA for TYTON pipes corresponds to the C class;
Thick frame: All coatings possible, or else only Zink Plus
*Inside/outside
**Weight ZMU / Weight (Volume) of cement mortar coating

Compatibility
Unless otherwise stated, all fitting sockets comply with EN 28 603 (TYTON). This means that TYTON SIT PLUS seals can also be inserted into these sockets. This creates the frictional locking BRS push-in socket joint.

Installation lengths
Unless otherwise stated, installation lengths "Lu" of the fittings of series A comply with EN 545

Flange fittings (see Chapter 6)
When ordering flange fittings, nominal pressure level "PN" must be specified. Accessories such as hexagon head screws, nuts, washers and flat seals can be obtained from specialist dealers.

Coating (see Chapter 7)
All fittings shown below have an epoxy resin coating of at least 250 µm on the inside and outside, unless otherwise stated. The coating complies with EN 14 901 and the requirements of the Quality Assurance Association for Heavy-Duty Corrosion Protection (GSK). This means that all fittings in accordance with EN 545 – Annex D.2.3 – can be installed in ground of any corrosiveness.

Our WKG system is used for frost-sensitive pipes, such as bridge pipelines, pipes laid aboveground or underground pipes that are buried far down. Further information on this can be found in Chapter 7.5.

4.3 BRS FITTINGS
Positive locking joints

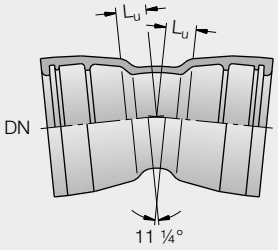
Permissible component operating pressure (PFA)
(unless otherwise stated)

DN	BRS PFA [bar] [1) 2)]
80	32
100	32
125	25
150	25
200	25
250	25
300	25
350	25
400	16
500	16
600	10

1) PFA: Maximum permissible component operating pressure in bar; PMA = 1.2 × PFA; PEA = 1.2 × PFA + 5
2) PFA depends on the C class of the pipe used.

Scope of delivery
The delivery of socket fittings includes the necessary seals and the additionally required accessory parts for screw sockets or gland nut sockets (slide rings, threaded ring, gland nut ring, hammer head bolts). Flat seals, bolts, nuts and washers for flange seals are not included in the scope of delivery.

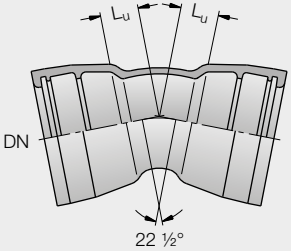
4.3 BRS FITTINGS
11° MMK FITTINGS
11° double socket elbows



DN	Dimensions [mm] Lu	PFA * [bar]	Weight ~ [kg]
80	30	100	7.5
100	30		8.5
125	35	64	12.8
150	35		16.5
200	40		24.9
250	50	50	34.2
300	55		43.0
350	60		60.5
400	65	40	70.9
500	75		100.0
600	85		140.0
700	95	30	190.7
800	110		271.2
900	120		393.5
1000	130		495.7

* Note reduction of the pressure application range when using BRS
(see catalogue page 149)

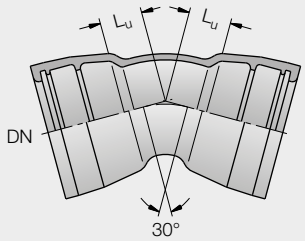
4.3 BRS FITTINGS
22° MMK FITTINGS
22° double socket elbows



DN	Dimensions [mm] Lu	PFA * [bar]	Weight ~ [kg]
80	40	100	7.7
100	40		9.4
125	50	64	13.3
150	55		17.5
200	65		21.0
250	75	50	30.7
300	85		40.4
350	95		64.6
400	110	40	80.2
500	130		100.4
600	150		140.5
700	175	30	185.7
800	195		315.8
900	220		456.0
1000	240		575.9

* Note reduction of the pressure application range when using BRS
(see catalogue page 149)

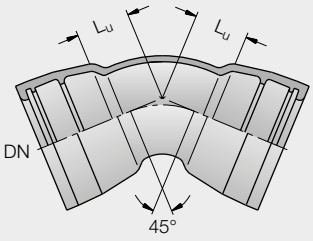
4.3 BRS FITTINGS
MMK FITTINGS 30
30° double socket elbows



DN	Dimensions [mm] Lu	PFA * [bar]	Weight ~ [kg]
80	45	100	7.7
100	50		9.7
125	55	64	14.0
150	65		18.0
200	80		22.0
250	95	50	32.0
300	110		43.2
350	125		71.5
400	140	40	85.3
500	180		109.2
600	200		155.9
700	230	30	275.3
800	260		345.9
900	290		496.3
1000	320		630.3

* Note reduction of the pressure application range when using BRS
(see catalogue page 149)

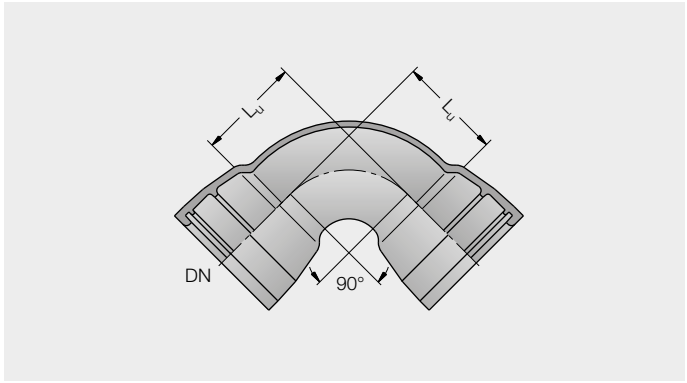
4.3 BRS FITTINGS
MMK FITTINGS 45
45° double socket elbows



DN	Dimensions [mm] Lu	PFA * [bar]	Weight ~ [kg]
80	55	100	8.1
100	65		10.0
125	75	64	14.1
150	85		18.4
200	110		24.6
250	130	50	35.7
300	150		48.7
350	175		76.9
400	195	40	86.0
500	240		127.0
600	285		183.6
700	330	30	296.7
800	370		406.1
900	415		577.9
1000	460		737.2

* Note reduction of the pressure application range when using BRS
(see catalogue page 149)

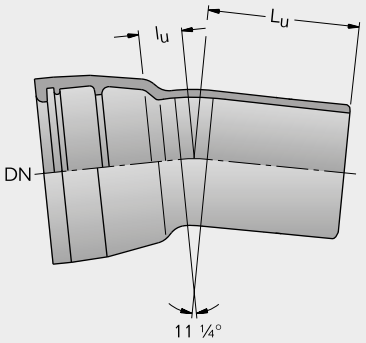
4.3 BRS FITTINGS
MMQ FITTINGS
90° double socket elbows



DN	Dimensions [mm] Lu	PFA * [bar]	Weight ~ [kg]
80	100	100	8.2
100	120		10.6
125	145	64	15.6
150	170		19.6
200	220		30.9
250	270	50	50.6
300	320		69.1
350 1)	410		96.8
400 1)	430	40	119.0
500 1)	550		199.4
600 1)	645		365.0
700 1)	720	30	449.0
800 1)	800		613.0

1) In accordance with company standard; * Note reduction of the pressure application range when using BRS (see catalogue page 149)

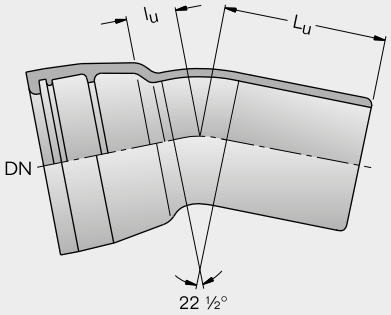
4.3 BRS FITTINGS
MK FITTINGS 11
11° elbow sockets



DN	Dimensions [mm] Lu	lu	PFA * [bar]	Weight ~ [kg]
80	240	30	100	7.6
100	243	33		9.8
125	261	36	64	14.0
150	284	40		18.0
200	311	46		27.0
250	255	50	50	37.8
300	260	60		47.0
350	235	65		46.0
400	238	70	40	66.9
500	250	85		83.2
600	287	95		163.0
700	340	110	30	249.0
800	375	125		286.0

* Note reduction of the pressure application range when using BRS (see catalogue page 149)

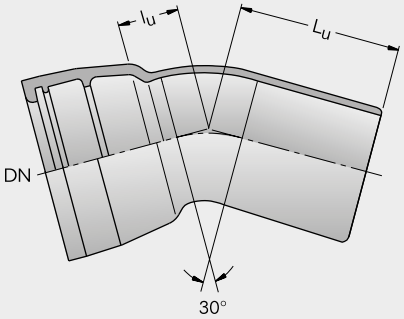
4.3 BRS FITTINGS
MK FITTINGS 22
22° elbow sockets



DN	Dimensions [mm]		PFA * [bar]	Weight ~ [kg]
	Lu	lu		
80	248	38	100	8.1
100	253	43		9.7
125	274	49	64	15.1
150	299	55		18.4
200	331	66		29.2
250	260	75	50	37.8
300	265	90		50.2
350	270	100		52.0
400	278	110	40	76.7
500	300	135		97.0
600	357	155		163.0
700	420	190	30	336.0
800	455	205		460.0

* Note reduction of the pressure application range when using BRS
(see catalogue page 149)

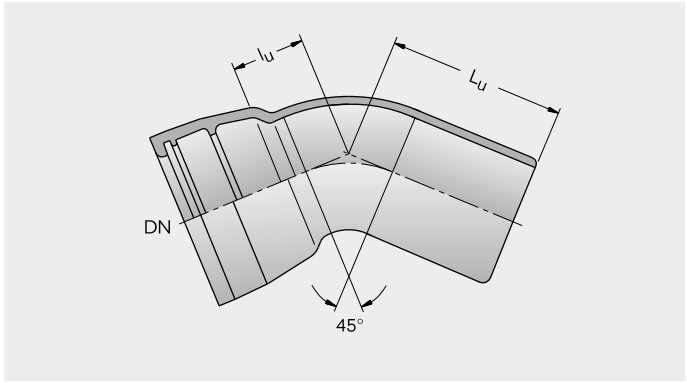
4.3 BRS FITTINGS
MK FITTINGS 30
30° elbow sockets



DN	Dimensions [mm]		PFA * [bar]	Weight ~ [kg]
	Lu	lu		
80	253	44	100	7.4
100	260	50		10.8
125	283	57	64	15.1
150	309	65		20.0
200	345	80		30.8
250	270	95	50	38.9
300	280	110		52.9
350	295	125		56.0
400	308	140	40	76.5
500	335	170		107.0
600	412	200		178.0
700	480	250	30	286.0
800	510	260		350.0

* Note reduction of the pressure application range when using BRS
(see catalogue page 149)

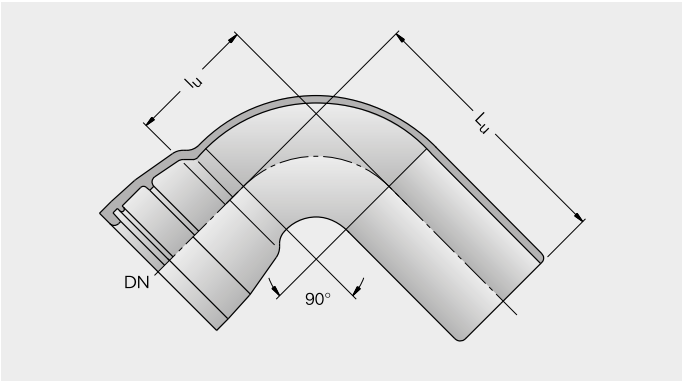
4.3 BRS FITTINGS
MK FITTINGS 45
45° elbow sockets



DN	Dimensions [mm] Lu	lu	PFA * [bar]	Weight ~ [kg]
80	265	55	100	8.4
100	274	65		10.8
125	301	76	64	16.2
150	331	87		20.5
200	374	109		33.5
250	300	130	50	44.3
300	315	155		59.4
350	345	175		68.0
400	368	200	40	91.0
500	405	240		187.0
600	529	285		250.5
700	610	380	30	441.0
800	625	370		–

* Note reduction of the pressure application range when using BRS
(see catalogue page 149)

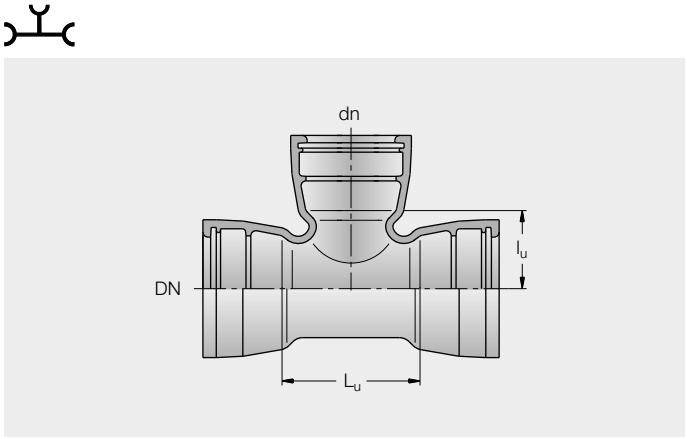
4.3 BRS FITTINGS
MQ FITTINGS
90° elbow sockets



DN	Dimensions [mm] Lu	lu	PFA * [bar]	Weight ~ [kg]
80	312	102	100	9.0
100	333	123		11.2
125	374	149	64	18.4
150	419	174		25.4
200	491	226		43.8
250	583	280	50	76.1
300	660	330		83.2
350	580	410		139.0
400	625	430	40	186.3
500	715	550		235.4
600	805	645		314.0
700	900	720	30	473.0
800	1080	800		644.5

* Note reduction of the pressure application range when using BRS
(see catalogue page 149)

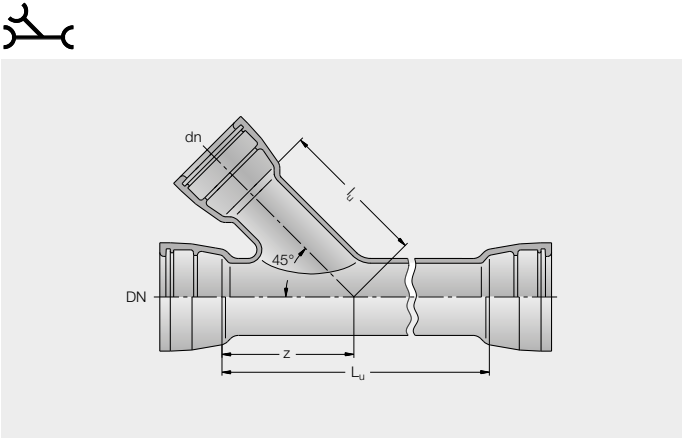
4.3 BRS FITTINGS
MMB FITTINGS
Double socket pieces with a 90° branched socket



DN	dn	Lu [mm]	lu [mm]	PFA * [bar]	Weight ~ [kg]
80	80	170	85	64	13.7
100	80	190	95	64	14.7
	100				16.6
125	80	170	105	64	16.5
	100	195	110		17.8
	125	225	110		19.9
150	80	170	120	62	19.9
	100	195			20.9
	150	255	125		25.5
200	80 [1]	200	145	50	30.0
	100				31.0
	150	255	150		41.0
	200	315	155		44.6
250	80 [1]	200	170	43	44.4
	100		175		45.3
	125 [1]		175		45.5
	150	260	180		50.4
	200	315	185		54.4
	250	375	190		63.9
300	80 [1]	205	195	40	55.5
	100	205	200		57.0
	150 [1]	320	200		60.7
	200	320	205		64.4
	250 [1]	430	210		79.6
	300	430	215		89.4

1) In accordance with company standard; * Note reduction of the pressure application range when using BRS (see catalogue page 149)

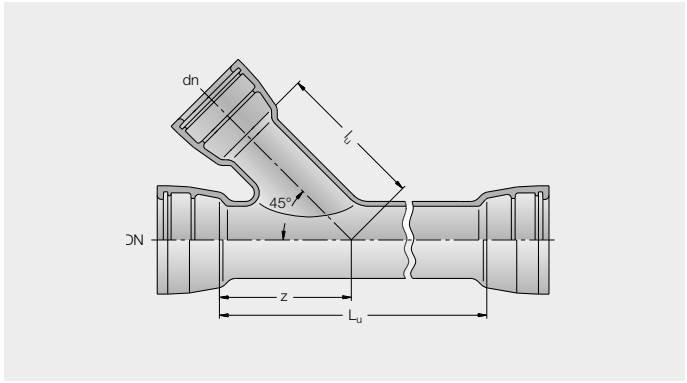
4.3 BRS FITTINGS
MMC FITTINGS
Double socket pieces with a 45° branched socket



DN	dn	Dimensions [mm]			Max. PFA * [bar]	Weight ~ [kg]
		Lu	lu	z		
80	80	270	200	200	16	20.5
100	80	300	250	250		23.1
	100					27.9
125	100	350	250	250		37.5
	125					38.3
150	80	380	300	300		30.3
	100					33.1
	150					35.9
200	100	500	360	360		52.2
	150		380	380		57.5
	200					59.8
250	100	600	395	395		61.0
	150					64.2
	200		430	430		93.6
	250		460	460		111.9
300	100	700	430	430		81.0
	150					84.2
	200		500	500		85.2
	250					117.4
	300		525	525		131.2
350	150	700	470	470		143.5
	200		510	510		149.8
	250		530	530		160.5
	300		570	610		165.2
	350	880	690	760		183.0

* Note reduction of the pressure application range when using BRS (see catalogue page 149)

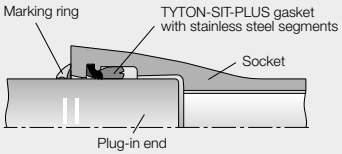
4.3 BRS FITTINGS
MMC FITTINGS
Double socket pieces with a 45° branched socket



DN	dn	Dimensions [mm] Lu	lu	z	Max. PFA * [bar]	Weight ~ [kg]
400	100	440	480	440	16	119.0
	125		490	450		125.6
	150					127.8
	200	640	570	580		144.5
	300	850	650	700		165.6
	400			650		193.0
500	100	450	590	515		150.8
	150					160.0
	200	740	620	550		200.6
	250		640	620		209.3
	300		720	680		213.5
	400	850		750		241.0
	500	1040	845	845		357.0
600	150	750	750	620		215.0
	200					218.5
	250		775	680		222.0
	300		800	740		229.5
	400	1150		765		367.0
	500	1210	920	915		448.0
	600		985	975		471.0
700	200	575	825	675		272.0
	300	925	885	810		398.0
	400		940	890		408.5
	500	1080	1020	990		596.3
	600	1380	1070	1055		653.0
	700		1140	1140		709.0
800	600	1250	1150	1110		699.5
	800	1550	1275	1275		964.0

* Note reduction of the pressure application range when using BRS
(see handbook page 149)

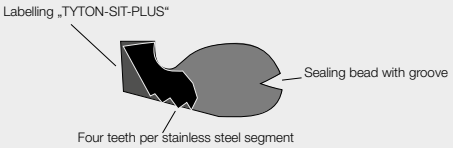
4.4 Installation instructions
BRS push-in socket joint
DN 80 to DN 600



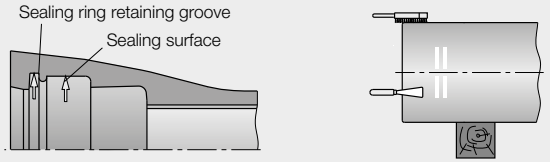
Scope of application
These installation instructions apply to pipes, fittings and valves made of ductile cast iron in accordance with EN 545 and EN 28 650 with a longitudinal positive locking BRS push-in socket joint in accordance with EN 28 603. Special installation instructions are available for the installation and fitting of other longitudinal positive locking joints and/or pipes with cement mortar coating (ZMU). For recommendations for transport, storage and installation, see Chapter 9. For laying tools and equipment, see Chapter 8. The number of joints to be secured must be specified in accordance with DVGW data sheet GW 368.

Note: Before using non-positive locking joints in culvert pipes, bridge pipelines and exposed pipes, as well as before installation on steep slopes, in protective pipes and collectors or under unstable ground conditions, our Application Technology department should always be consulted. The BRS joint is not suitable for trenchless installation procedures.

Please note:
Three essential distinguishing features of the TYTON SIT PLUS seal are:



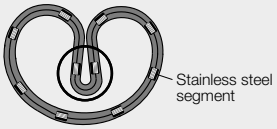
4.4 Installation instructions
BRS push-in socket joint
DN 80 to DN 600



Cleaning
The surfaces marked with an arrow on the sealing surface and retaining groove must be cleaned, and any accumulations of paint must be removed. To clean the retaining groove, use a scraper, e.g a bent screwdriver. Clean the spigot end up to the line marking. Remove impurities and any colour residues.

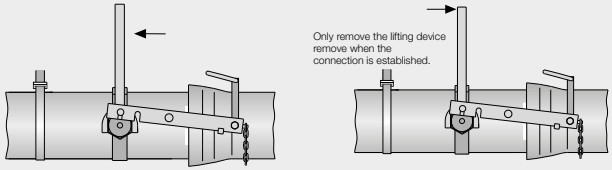
Assembly of the joint
Insertion of the TYTON SIT PLUS seal in accordance with the installation instructions for the TYTON push-in socket joint. Clean the TYTON SIT PLUS seal, press it together in a heart shape and insert it into the seal seat.

Apply a thin layer of lubricant to the used TYTON SIT PLUS seal. Push the identification ring, which has been marked with a white colour strip and profiled, onto the spigot end. Apply a thin layer of lubricant to the spigot end – especially at the chamfers – and then insert it into the socket until it is centred on the TYTON SIT PLUS seal. Mount the installation device on the socket and spigot end, thus pulling the spigot end of the pipe or fitting that is to be inserted into the socket of the pipe that has already been laid. Avoid deflection here.



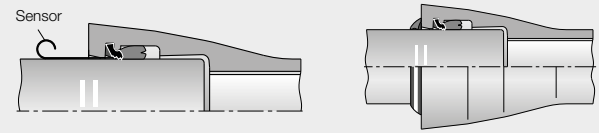
Please note: The inner loop must be positioned between two segments.

4.4 Installation instructions
BRS push-in socket joint
DN 80 to DN 600



Push the spigot end into the socket until the first marking line is no longer visible. Twisting of the joint is now no longer permitted.

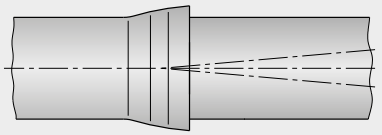
Locking
Pull or push the pipe out of the socket until the TYTON SIT PLUS stainless steel segments engage, e.g. using a laying tool.
The joint is now longitudinal positive locking.



After producing the joint, you must check that the TYTON SIT PLUS seal fits correctly around the entire circumference using the supplied button. When doing so, it must be ensured that you penetrate into the gap between the spigot end and the front face of the socket at a uniform depth over the entire circumference. The penetration depth is usually greater in the area of the segments than in the rest of the seal. If there is an unusually large penetration depth at one or more points, there may be a loop and therefore a leak here. In this case, the joint must be disassembled using a carrying anvil and disassembly plates, and the seal seat must be checked.

Please note: Do not reuse the removed TYTON SIT PLUS seal.

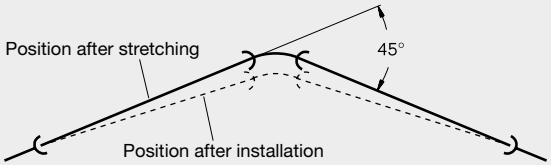
Labelling the joint
We supply a profiled rubber ring with a white colour strip on the casing surface for permanent identification of the longitudinal positive locking push-in socket joint. The identification ring is arranged as shown in the figure, and must therefore be pushed onto the spigot end before the joint is fitted.



Bending
Once the joint has been completed, pipes and fittings can be bent:

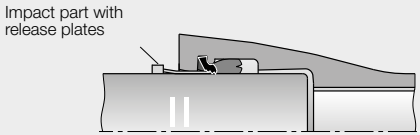
DN 80 to DN 350 – maximum 3°/ DN 400 to DN 600 – maximum 2°

1° deflection results in a deviation of approx. 10 cm from the axis of the previously installed pipe or fitting over a pipe length of 6 m; e.g. at 3° = 30 cm.

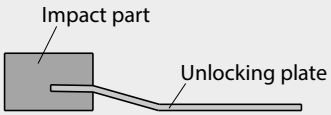


Mounting instructions
It should be noted that, depending on the internal pressure and the joint tolerances, stretching of up to approx. 8 mm per joint can occur. In order to take account of the stretching path of the pipe during the application of pressure, the joints at the elbows are set to negative with the max. permissible deflection.

Cutting pipes to length
Ensure that the pipes can be cut (see page 316). Transfer the line markings from the original spigot end to the cut spigot end.



Disassembly
Insert the pipe into the socket as far as it will go.
Coat the disassembly plates with lubricant and drive them into the socket gap all the way round using a carrying anvil. Then dismantle the joint using the laying tool or the dismantling clamp.



A disassembling tool consists of a carrying anvil and the number of disassembling plates as displayed in the following table.

DN	80	100	125	150	200	250	300	350	400	500	600
Quantity	4	4	5	6	8	10	12	14	16	19	23

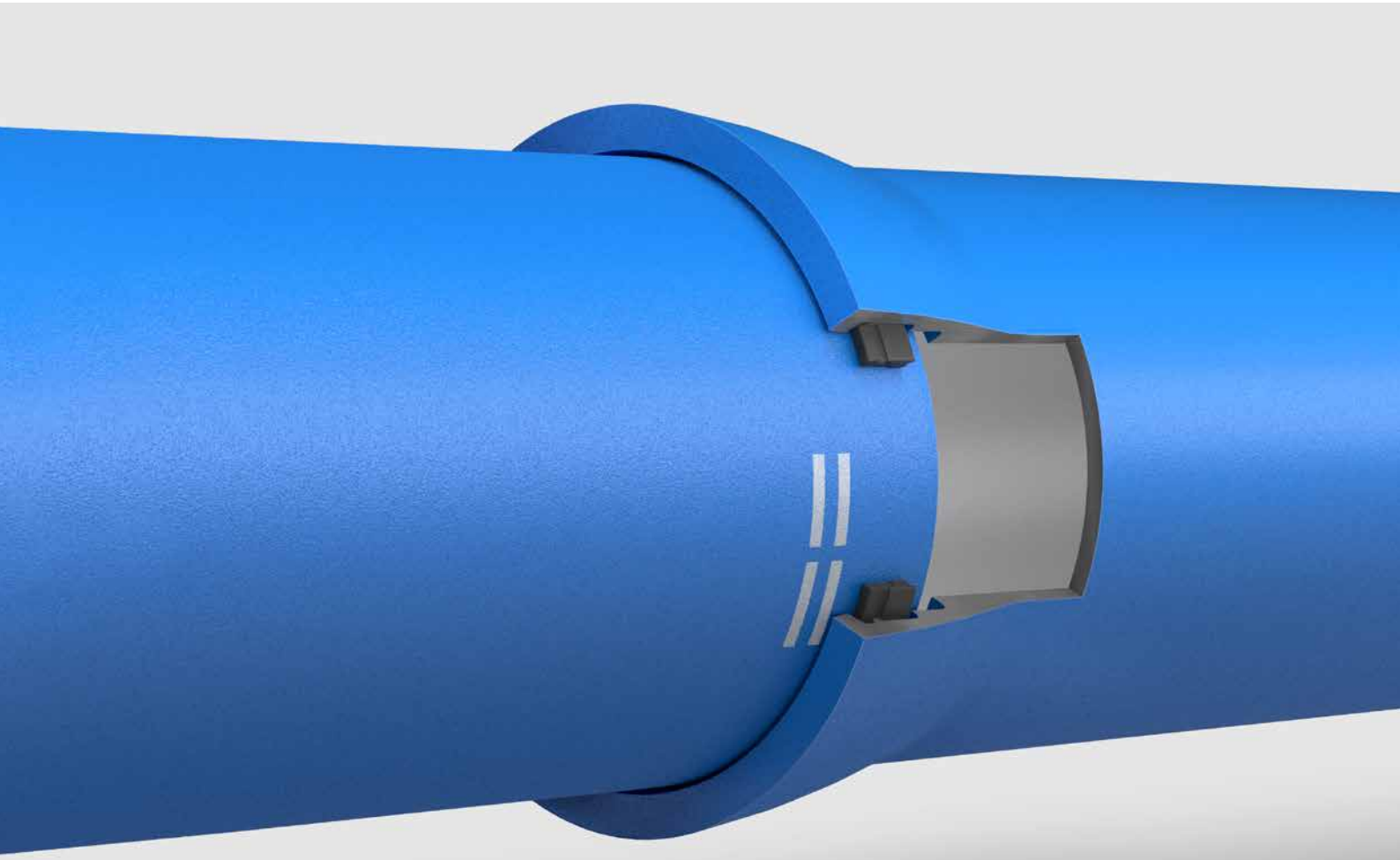
A disassembled TYTON SIT PLUS seal must not be reused.

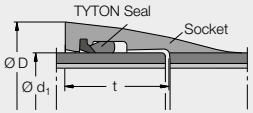
5

NON-LONGITUDINAL POSITIVE LOCKING

TYTON, THREADED BUSH AND GLAND NUT JOINTS

Pipes, fittings and installation instructions





This chapter deals exclusively with non-positive locking push-in socket joints.

In the following, these are the non-longitudinal positive locking joints:

- TYTON joint (TYT) according to EN 28 603 – DN 80 to DN 1000.
- The TYTON joint has been the leading joint for pipes and fittings on the international market since 1965. It can be angled up to a maximum of 5°, it is not affected by roots, it is easy to install, and it is watertight at any internal water pressure.
- Screw socket joint according to EN 28 601 – DN 40 to DN 400
- Available for some fittings, such as EU fittings or U fittings.
- Particularly suitable for subsequent integration.
- Gland nut socket joint according to EN 28 602 – DN 400 to DN 1000
- Available for some fittings, such as EU fittings or U fittings.
- Particularly suitable for subsequent integration.

Applications/benefits
Pipes and fittings with non-longitudinal positive locking joints are primarily designed for conventional installation in an open trench. Pushing into the pipe relining (cf. DVGW GW 320-1) with TYTON pipes is an exception.

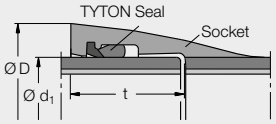
Before using non-longitudinal positive locking joints in culvert pipes, bridge pipelines and exposed pipes, as well as before installation on steep slopes, in protective pipes and collectors or under unstable ground conditions, our Application Technology department should always be consulted.

For non-longitudinal positive locking systems, abutments or fixed points (e.g. in accordance with DVGW GW 310) must be provided at elbows, branches, reducers, etc. An estimated design of abutments or fixed points is dealt with in Chapter 8.

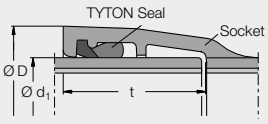
PFA – permissible component operating pressure
Ductile cast-iron pipes with non-longitudinal positive locking push-in socket joints (e.g. TYTON) are categorised into pressure classes in accordance with EN 545. These pressure classes are also designated as C classes. The maximum PFA of a pipe corresponds to its pressure class (e.g. C 50 = PFA 50 bar). **This applies exclusively to pipes without longitudinal positive locking.** If the same pipe is designed with longitudinal positive locking, for example using a TYTON SIT PLUS seal, the permissible PFA is reduced.

Example: DN 200 to C 50
This pipe has a permissible PFA of 50 bar when designed without longitudinal positive locking. When using a TYTON SIT PLUS seal, the PFA is reduced to 16 bar. For the permissible PFA for our BRS joint, depending on the C class and nominal size, see from page 149 onwards.

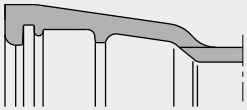
5.1 TYTON overview
TYTON push-in socket joint



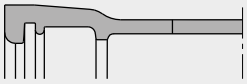
DN 80 to DN 600



DN 700 to DN 1000



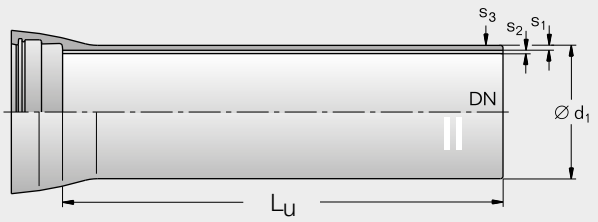
Socket for fittings



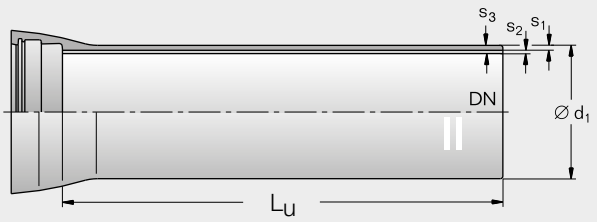
Socket for EU fittings

DN	Dimensions [mm]			Weight ~ [kg]				Maximum deflection
					Socket			
	Ø d1	Ø D	t	Pipe	Fitting	EU fitting	Seal	
80	98	142	84	3.4	2.8	2.4	0.13	5°
100	118	163	88	4.3	3.3	3.1	0.16	
125	144	190	91	5.7	4.5	4.0	0.19	
150	170	217	94	7.1	5.6	4.9	0.22	
200	222	278	100	10.3	8.0	7.1	0.37	
250	274	336	105	14.2	11.1	9.7	0.48	
300	326	385	110	18.6	14.3	12.5	0.67	
350	378	448	110	23.7	17.1	15.2	0.77	4°
400	429	500	110	29.3	20.8	18.6	1.1	
500	532	607	120	42.8	31.7	27.6	1.6	3°
600	635	732 *	120	59.3	42.3	36.2	2.3	
700	738	849 *	197	79.1	71.2	59.1	4.3	
800	842	960 *	209	102.6	95.4	79.8	5.2	
900	945	1073 *	221	129.9	150.3	122.7	6.3	
1000	1048	1188 *	233	161.3	186.9	152.1	8.3	

5.2 TYTON PIPES
DN 80 to DN 1000
According to EN 545:2010



5.2 TYTON PIPES
DN 80 to DN 1000
According to EN 545:2010



External coatings
Zinc coating with cement mortar coating (ZMU)
Zinc coating with finishing layer (ZIPOX)
Zinc-aluminium coating with finishing layer ZIPOX+, (DUCPUR to DN 700)
WKG coating

Internal coatings
Polyurethane
Cement mortar lining based on aluminous cement
Cement mortar lining based on blast furnace cement

DN	d1 [mm]	C 30 (6 m) S1	C 30 (6 m) Weight [kg]	C 40 (6 m) S1	C 40 (6 m) Weight [kg]	C 50 (6 m) S1	C 50 (6 m) Weight [kg]	C 64 (6 m) S1	C 64 (6 m) Weight [kg]	C 100 (6 m) S1	C 100 (6 m) Weight [kg]	Weight ZMU** [kg]	PUR weight * [kg]	s2	s3
80	98 +1/-2.7					3.5	79.1			4.7 3)	94.0	19.5	5.4/3.8	4	
100	118 +1/-2.8					3.5	98.7			4.7 3)	118.4	24.0	5.7/4.5	4	
125	144 +1/-2.8					3.5	125.2	4.8 3)	150.4	5.0	155.5	28.0	6.9/5.7	4	
150	170 +1/-2.9					3.7 1)	154.3	4.7 2) 5.0 3)	175.4 183.8	5.9	205.8	33.0	8.4/6.4	4	
200	222 +1/-3.0					3.9	209.1	5.0 2) 5.5 3)	245.4 259.2	7.7	323.1	43.0	12.3/8.1	4	
250	274 +1/-3.1			4.2 1)	272.9	5.2 2)	316.3	6.1	347.4	9.5	468.1	52.0	15.5/9.9	4	
300	326 +1/-3.3			4.6	351.8	5.7 2)	410.0	7.3	475.8			63.0	18.4/11.6	4	5
350	378 +1/-3.4	4.7	416.1	6.0 2)	496.0	6.6	524.8	8.5	615.6			72.0	20.4/13.3	5	
400	429 +1/-3.5	4.8	513.3	6.4 2)	601.3	7.5	661.5	9.6	775.4			82.0	23.3/14.9	5	
500	532 +1/-3.8	5.6	707.4	7.5	837.4	9.3	959.7					101.0	29.1/18.1	5	
600	635 +1/-4.0	6.7	982.1	8.9	1162.0							121.0	35.0/21.2	5	
700	738 +1/-4.3	7.8	1268.8	10.4	1516.0							140.0	40.8/24.2	6	
800	842 +1/-4.5	8.9	1631.8									160.0		6	
900	945 +1/-4.8	10.0	1994.4									179.0		6	
1000	1048 +1/-5,0	11.1	2395.9									199.0		6	

1) C 40 in accordance with EN 545:2010; 2) K9 in accordance with EN 545:2010;
3) K10 in accordance with EN 545:2010;
s1) Minimum wall thickness in mm; s2) Nominal value of the cement mortar lining layer thickness in mm;
s3) Nominal value of the cement mortar coating in mm; weight of the pipes = theoretical specifications in kg, incl. cement mortar lining, zinc-aluminium coating and epoxy resin finishing layer; weight of cement mortar coating = additional weight of the cement mortar coating in kg;

Installation length Lu = 6 m and 5 m. Special lengths on request
***PUR mass, internal coating / chapter 3.2 page 91 ff.**

PFA: Maximum permissible component operating pressure in bar. PMA = 1.2 x PFA. PEA = 1.2 x PFA + 5.
The PFA for TYTON pipes corresponds to the C class;
Thick frame: All coatings possible, or else only Zink Plus
*Inside/outside
**Weight ZMU / Weight (Volume) of cement mortar coating

Compatibility
Unless otherwise stated, all fitting sockets comply with EN 28 603 (TYTON). This means that TYTON SIT PLUS seals can also be inserted into these sockets. This creates the frictional locking BRS push-in socket joint.

Installation lengths
Unless otherwise stated, installation lengths "Lu" of the fittings of series A comply with EN 545

Flange fittings (see Chapter 6)
When ordering flange fittings, nominal pressure level "PN" must be specified. Accessories such as hexagon head screws, nuts, washers and flat seals can be obtained from specialist dealers.

Coating (see Chapter 7)
All fittings shown below have an epoxy resin coating of at least 250 µm on the inside and outside, unless otherwise stated. The coating complies with EN 14 901 and the requirements of the Quality Assurance Association for Heavy-Duty Corrosion Protection (GSK). This means that all fittings in accordance with EN 545 – Annex D.2.3 – can be installed in ground of any corrosiveness.

Our WKG system is used for frost-sensitive pipes, such as bridge pipelines, pipes laid aboveground or underground pipes that are buried far down. Further information on this can be found in Chapter 7.6.

5.3 TYTON FITTINGS
With non-positive locking joints

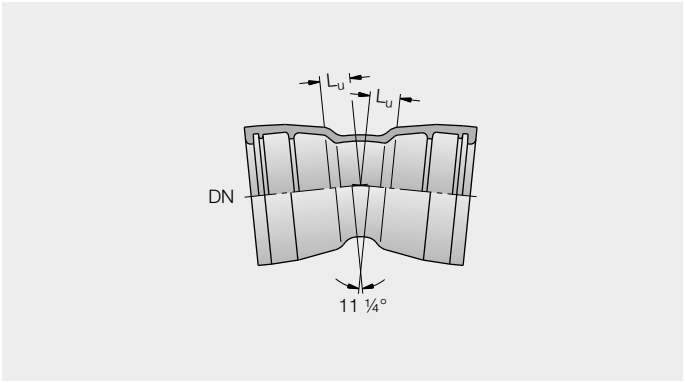
Permissible component operating pressure (PFA)
(unless otherwise stated)

DN	TYTON	PFA [1] [bar] SMU	PFA [1] [bar] STB	PFA [1] [bar] Flange
80	100	16	By agreement	PFA = PN
100	100			
125	64			
150	64			
200	64			
250	50			
300	50			
350	50			
400	40			
500	40	By agreement	16	
600	40			
700	30			
800	30			
900	30			
1000	30			

1) PFA: Maximum permissible component operating pressure in bar; PMA = 1.2 × PFA; PEA = 1.2 × PFA + 5

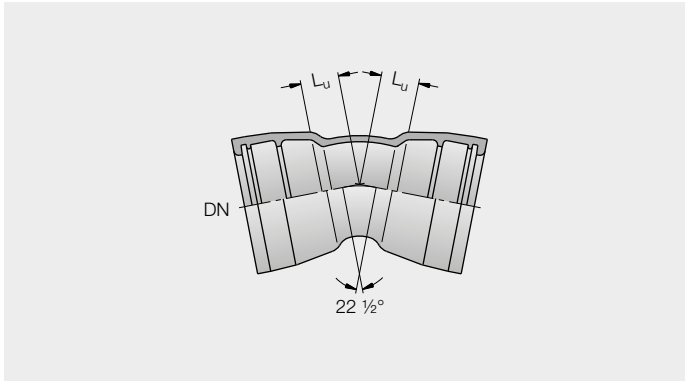
Scope of delivery
The delivery of socket fittings includes the necessary seals and the additionally required accessory parts for screw sockets or gland nut sockets (slide rings, threaded ring, gland nut ring, hammer head bolts). Flat seals, bolts, nuts and washers for flange seals are not included in the scope of delivery.

5.3 TYTON MMK FITTINGS 11
11° double socket elbows



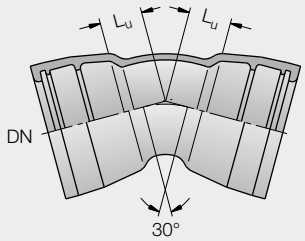
DN	Dimensions [mm] Lu	PFA [bar]	Weight ~ [kg]
80	30	100	7.5
100	30		8.5
125	35	64	12.8
150	35		16.5
200	40		24.9
250	50	50	34.2
300	55		43.0
350	60		60.5
400	65	40	70.9
500	75		100.0
600	85		140.0
700	95	30	190.7
800	110		271.2
900	120		393.5
1000	130		495.7

5.3 TYTON MMK FITTINGS 22
22° double socket elbows



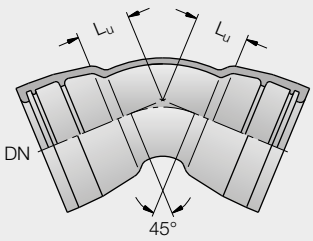
DN	Dimensions [mm] Lu	PFA [bar]	Weight ~ [kg]
80	40	100	7.7
100	40		9.4
125	50	64	13.3
150	55		17.5
200	65		21.0
250	75	50	30.7
300	85		40.4
350	95		64.6
400	110	40	80.2
500	130		100.4
600	150		140.5
700	175	30	185.7
800	195		315.8
900	220		456.0
1000	240		575.9

5.3 TYTON MMK FITTINGS 30
30° double socket elbows



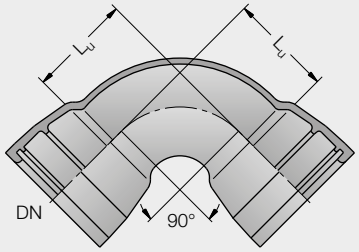
DN	Dimensions [mm] Lu	PFA [bar]	Weight ~ [kg]
80	45	100	7.7
100	50		9.7
125	55	64	14.0
150	65		18.0
200	80		22.0
250	95	50	32.0
300	110		43.2
350	125		71.5
400	140	40	85.3
500	180		109.2
600	200		155.9
700	230	30	275.3
800	260		345.9
900	290		496.3
1000	320		630.3

5.3 TYTON MMK FITTINGS 45
45° double socket elbows



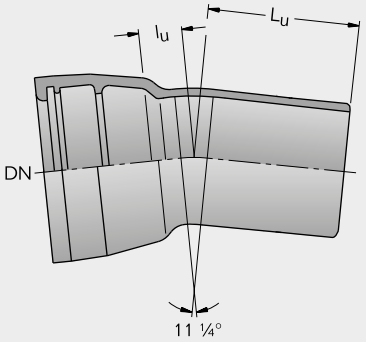
DN	Dimensions [mm] Lu	PFA [bar]	Weight ~ [kg]
80	55	100	8.1
100	65		10.0
125	75	64	14.1
150	85		18.4
200	110		24.6
250	130	50	35.7
300	150		48.7
350	175		76.9
400	195	40	86.0
500	240		127.0
600	285		183.6
700	330	30	296.7
800	370		406.1
900	415		577.9
1000	460		737.2

5.3 TYTON MMQ FITTINGS
90° double socket elbows



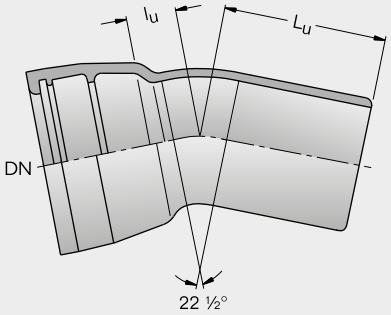
DN	Dimensions [mm] Lu	PFA [bar]	Weight ~ [kg]
80	100	100	8.2
100	120		10.6
125	145	64	15.6
150	170		19.6
200	220		30.9
250	270	50	50.6
300	320		69.1
350 [1]	410		96.8
400 [1]	430	40	119.0
500 [1]	550		199.4
600 [1]	645		365.0
700 [1]	720	30	449.0
800 [1]	800		613.0

5.3 TYTON MK FITTINGS 11
11° elbow sockets



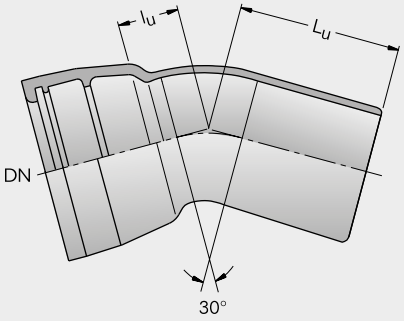
DN	Dimensions [mm] Lu	lu	PFA [bar]	Weight ~ [kg]
80	240	30	100	7.6
100	243	33		9.8
125	261	36	64	14.0
150	284	40		18.0
200	311	46		27.0
250	255	50	50	37.8
300	260	60		47.0
350	235	65		46.0
400	238	70	40	66.9
500	250	85		83.2
600	287	95		163.0
700	340	110	30	249.0
800	375	125		286.0

5.3 TYTON MK FITTINGS 22
22° elbow sockets



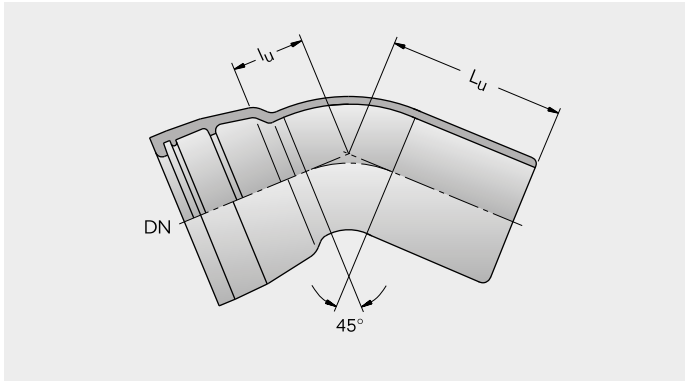
DN	Dimensions [mm]		PFA [bar]	Weight ~ [kg]
	Lu	lu		
80	248	38	100	8.1
100	253	43		9.7
125	274	49	64	15.1
150	299	55		18.4
200	331	66		29.2
250	260	75	50	37.8
300	265	90		50.2
350	270	100		52.0
400	278	110	40	76.7
500	300	135		97.0
600	357	155		163.0
700	420	190	30	336.0
800	455	205		460.0

5.3 TYTON MK FITTINGS 30
30° elbow sockets



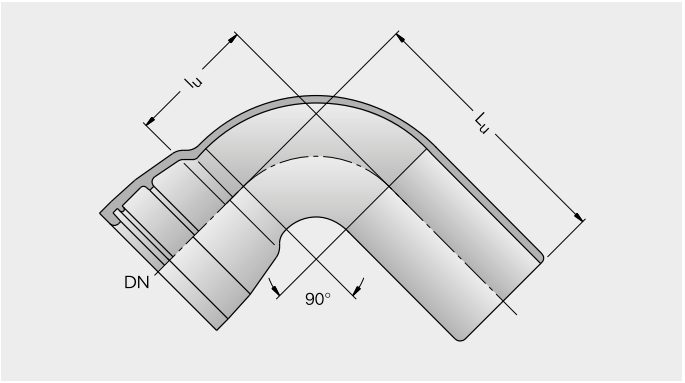
DN	Dimensions [mm]		PFA [bar]	Weight ~ [kg]
	Lu	lu		
80	253	44	100	7.4
100	260	50		10.8
125	283	57	64	15.1
150	309	65		20.0
200	345	80		30.8
250	270	95	50	38.9
300	280	110		52.9
350	295	125		56.0
400	308	140	40	76.5
500	335	170		107.0
600	412	200		178.0
700	480	250	30	286.0
800	510	260		350.0

5.3 TYTON MK FITTINGS 45
45° elbow sockets



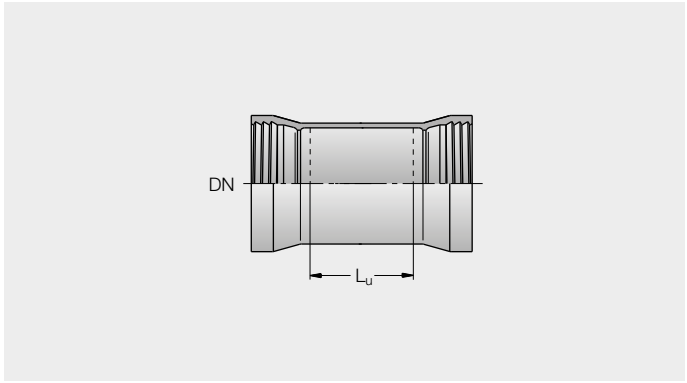
DN	Dimensions [mm] Lu	lu	PFA [bar]	Weight ~ [kg]
80	265	55	100	8.4
100	274	65		10.8
125	301	76	64	16.2
150	331	87		20.5
200	374	109		33.5
250	300	130	50	44.3
300	315	155		59.4
350	345	175		68.0
400	368	200	40	91.0
500	405	240		187.0
600	529	285		250.5
700	610	380	30	441.0
800	625	370		–

5.3 TYTON MQ FITTINGS
90° elbow sockets



DN	Dimensions [mm] Lu	lu	PFA [bar]	Weight ~ [kg]
80	312	102	100	9.0
100	333	123		11.2
125	374	149	64	18.4
150	419	174		25.4
200	491	226		43.8
250	583	280	50	76.1
300	660	330		83.2
350	580	410		139.0
400	625	430	40	186.3
500	715	550		235.4
600	805	645		314.0
700	900	720	30	473.0
800	1080	800		644.5

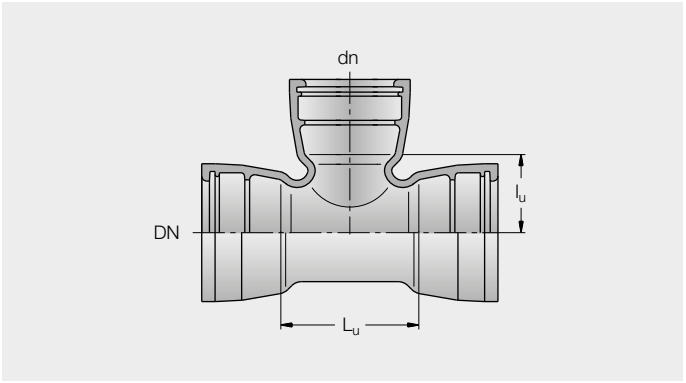
5.3 TYTON U FITTINGS
Push-on sockets



DN	Joint	Lu [mm]	PFA [bar]	Weight[1] ~ [kg]
80	SMU	160	16	7.7
100		160		9.3
125		165		12.5
150		165		14.6
200		170		22.2
250		175		30.0
300		180		37.2
350		185		47.0
400		190		60.3
500	STB	200		119.3
600		210		162.7
700		220		210.3
800		230		249.9
900		240		305.0
1000		250		386.0

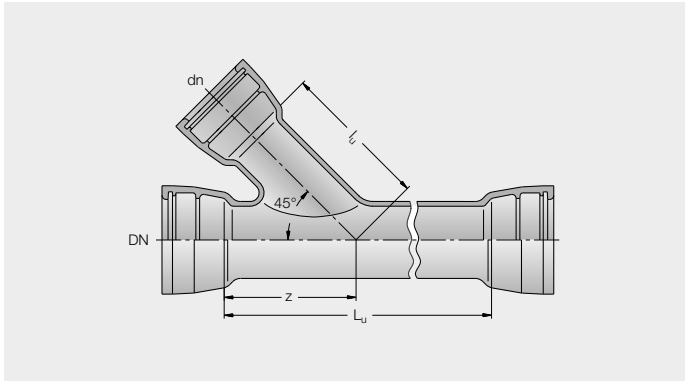
1) Without threaded ring or gland nut ring, without seal

5.3 TYTON MMB FITTINGS
Double socket pieces with a 90° branched socket



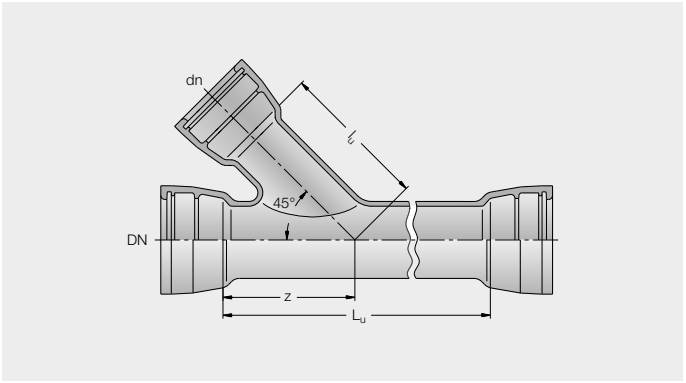
DN	dn	Lu [mm]	lu [mm]	PFA [bar]	Weight ~ [kg]
80	80	170	85	64	13.7
100	80	190	95	64	14.7
	100				16.6
125	80	170	105	64	16.5
	100	195	110		17.8
	125	225	110		19.9
150	80	170	120	62	19.9
	100	195			20.9
	150	255	125		25.5
200	80 [1]	200	145	50	30.0
	100				31.0
	150	255	150		41.0
	200	315	155		44.6
250	80 [1]	200	170	43	44.4
	100		175		45.3
	125 [1]		175		45.5
	150	260	180		50.4
	200	315	185		54.4
	250	375	190		63.9
300	80 [1]	205	195	40	55.5
	100	205	200		57.0
	150 [1]	320	200		60.7
	200	320	205		64.4
	250 [1]	430	210		79.6
	300	430	215		89.4

1) In accordance with company standard



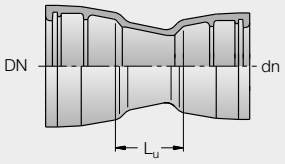
DN	dn	Dimensions [mm]			Max. PFA [bar]	Weight ~ [kg]
		Lu	lu	z		
80	80	270	200	200	16	20.5
100	80	300	250	250		23.1
	100					27.9
125	100	350	250	250		37.5
	125					38.3
150	80	380	300	300		30.3
	100					33.1
	150					35.9
200	100	500	360	360		52.2
	150		380	380		57.5
	200					59.8
250	100	600	395	395		61.0
	150					64.2
	200		430	430		93.6
	250		460	460		111.9
300	100	700	430	430		81.0
	150					84.2
	200		500	500		85.2
	250					117.4
	300		525	525		131.2
350	150	700	470	470		143.5
	200		510	510		149.8
	250		530	530		160.5
	300		570	610		165.2
	350	880	690	760		183.0

5.3 TYTON MMC FITTINGS
Double socket pieces with a 45° branched socket



DN	dn	Dimensions [mm]			Max. PFA [bar]	Weight ~ [kg]
		Lu	lu	z		
400	100	440	480	440	16	119.0
	125		490	450		125.6
	150					127.8
	200	640	570	580		144.5
	300	850	650	700		165.6
	400			650		193.0
500	100	450	590	515		150.8
	150					160.0
	200	740	620	550		200.6
	250		640	620		209.3
	300		720	680		213.5
	400	850		750		241.0
	500	1040	845	845		357.0
600	150	750	750	620		215.0
	200					218.5
	250		775	680		222.0
	300		800	740		229.5
	400	1150		765		367.0
	500	1210	920	915		448.0
	600		985	975		471.0
700	200	925	825	675		272.0
	300		885	810		398.0
	400		940	890		408.5
	500	1080	1020	990		596.3
	600	1380	1070	1055		653.0
	700		1140	1140		709.0
800	600	1250	1150	1110		699.5
	800	1550	1275	1275		964.0

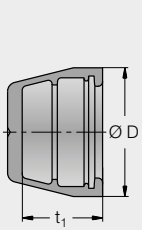
5.3 TYTON MMR FITTINGS
Double socket transition pieces



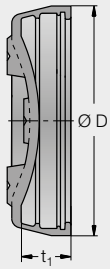
DN	dn	Lu [mm]	Max. PFA [bar]	Weight ~ [kg]
100	80	90	100	9.0
125	80	140	64	9.9
	100	100		9.8
150	80	190		14.6
	100	150		15.3
	125	100		15.4
200	100	250		18.3
	125	200		18.7
	150	150		18.7
250	125	300	50	30.1
	150	250		33.6
	200	150		33.9
300	150	350		46.6
	200	250		41.9
	250	150		42.8
350	200	360		45.3
	250	260		44.8
	300	160		43.6
400	250	360	40	70.2
	300	260		65.5
	350	160		68.0
500	350	500		138.3
	400	500		146.7
600 [1]	400	500		177.8
	500	500		181.8
700 [1]	500	500	30	331.5
	600	500		346.2
800	600	480		276.3
	700	280		247.0
900	700	480		363.0
	800	280		340.0
1000	800	480		453.0
	900	280		442.0

1) In accordance with company standard

5.3 TYTON O FITTINGS
Spigot end sealing caps



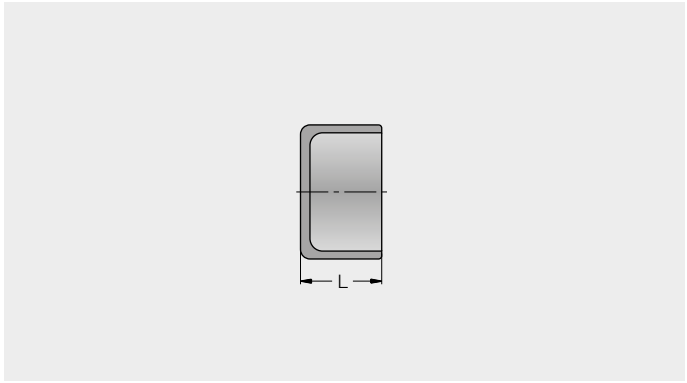
DN 80 to DN 250



DN 300 to DN 600

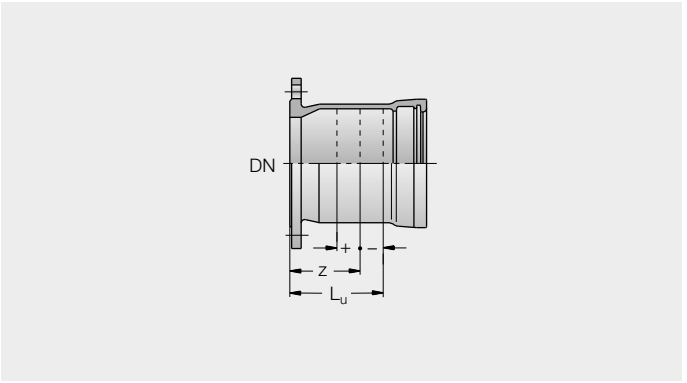
DN	Dimensions [mm]		Max. PFA [bar]	Weight ~ [kg]
	D	t1		
80	146	84	25	4.5
100	166	88		4.8
125	193	91		6.0
150	224	94		8.0
200	280	100		12.0
250	336	105		19.0
300	391	110		27.0
350	450	110		34.0
400	503	110		45.0
500	598	120		73.0
600	707	120		110.0

5.3 TYTON P FITTINGS
Socket sealing plug



DN	Joint	Dimensions [mm] L	Max. PFA [bar]	Weight ~ [kg]
40	TYT/SMU	82	16	1.0
80		90		3.0
100		98		4.0
125		99		6.0
150		103		7.5
200		108		12.0
250		120		18.0
300		125		25.5
350		125		37.5
400		125		46.5
500		173		80.0

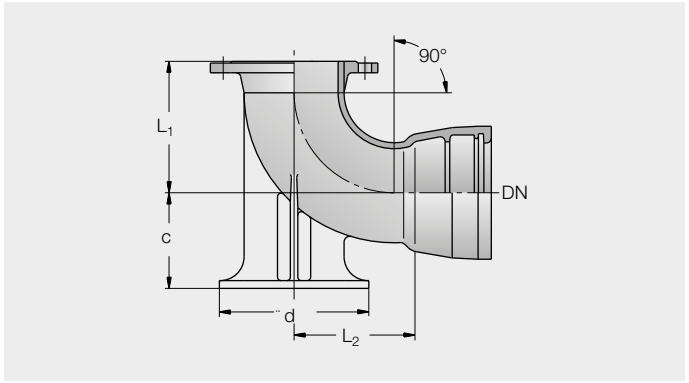
5.3 TYTON SOCKET FLANGE FITTINGS
EU FITTINGS
Flange socket pieces



DN	Joint	Dimensions [mm] Lu	z [1]	+/-	Weight ~ [kg] [2] PN10	PN16	PN25	PN40
80	TYT	130	86	40	7.5	7.5	7.5	7.5
	SMU				7.8	7.8	a.A.	a.A.
100	TYT	130	87	40	10.2	10.2	10.7	10.7
	SMU				10.2	10.2	a.A.	a.A.
125	TYT	135	91	40	11.4	11.4	12.0	13.2
	SMU				12.8	12.8	a.A.	a.A.
150	TYT	135	92	40	15.5	15.5	18.5	19.5
	SMU				15.5	15.5	a.A.	a.A.
200	TYT	140	97	40	19.8	19.8	22.0	26.5
	SMU				20.5	20.5	a.A.	a.A.
250	TYT	145	102	40	31.7	31.7	33.7	40.2
	SMU				30.7	30.7	a.A.	a.A.
300	TYT	150	107	40	44.0	44.0	49.8	54
	SMU				40.0	40.0	a.A.	a.A.
350	TYT	155	112	40	52.0	56.0	60.0	70.5
	SMU				48.0	49.0	a.A.	a.A.
400	TYT	160	117	40	63.6	67.6	83.6	105.6
	SMU				54.1	59.6	a.A.	a.A.
	STB				68.1	71.6	a.A.	a.A.
500	TYT	170	127	40	92.3	105.8	115.8	126.8
	STB				99.3	115.8	a.A.	a.A.
600	TYT	180	137	40	118.6	141.6	143.1	184.1
	STB				138.1	159.6	a.A.	a.A.
700	TYT	190	147	40	171.8	185.2	195.0	–
	STB				186.0	186.0	a.A.	
800	TYT	200	157	40	236.2	256.2	276.2	
	STB				238.5	250.0	a.A.	
900	TYT	210	167	40	274.2	271.2	345.0	
	STB				235.2	256.2	a.A.	
1000	TYT	220	177	40	332.1	347.1	442.1	
	STB				312.7	362.7	a.A.	

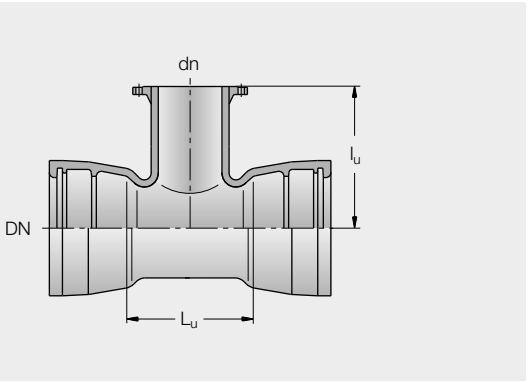
1) Standard gauge for installation, 2) Weights of gland nut socket joint/screw socket joint without gland nut ring or threaded ring;

5.3 TYTON EN FITTINGS
90° foot bends



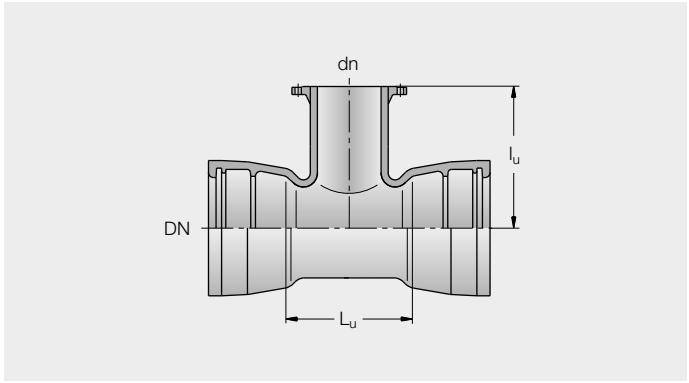
DN	Dimensions [mm]				Weight ~ [kg]			
	L1	L2	c	□ d	PN10	PN16	PN25	PN40
80	165	145	110	180	15.3	15.3	15.3	15.3
100	180	158	125	200	18.4	18.4	18.4	18.4

5.3 TYTON MMA FITTINGS
Double socket pieces with flanged branch



DN	dn	Dimensions [mm]		Weight ~ [kg]			
		Lu	lu	PN10	PN16	PN25	PN40
80	40 [1]	170	155	10.8	10.8	10.8	10.8
	50 [1]		160	11.4	11.4	11.4	11.4
	80		165	12.9	12.9	12.9	12.9
100	40 [1]	170	170	12.6	12.6	12.6	12.6
	50 [1]		170	13.2	13.2	13.2	13.2
	80		175	14.5	14.5	14.5	14.5
	100	190	180	15.8	15.8	16.3	16.3
125	40 [1]	170	185	16.0	16.0	16.0	16.0
	80		190	18.0	18.0	18.0	18.0
	100	195	195	19.3	19.3	19.8	19.8
	125	255	200	21.6	21.6	22.1	23.6
150	40 [1]	170	195	19.2	19.2	19.2	19.2
	50 [1]		200	19.9	19.9	19.9	19.9
	80		205	21.3	21.3	21.3	21.3
	100	195	210	22.7	22.7	23.2	23.2
	150	255	220	27.4	27.4	29.4	30.9
200	40 [1]	175	230	26.7	26.7	26.7	26.7
	50 [1]		230	28.0	28.0	28.0	28.0
	80		235	28.6	28.6	28.6	28.6
	100	200	240	30.4	30.4	30.9	30.9
	150	255	250	36.1	36.1	37.1	39.1
	200	315	260	42.2	41.7	43.7	49.2
250	80	180	265	37.9	37.9	37.9	37.9
	100	200	270	39.7	39.7	40.2	40.2
	150	260	280	46.3	46.3	47.3	49.3
	200	315	290	52.9	52.9	54.9	60.4
	250	375	300	61.0	60.5	64.5	74.5
300	80	180	295	47.2	47.2	47.2	47.2
	100	205	300	50.0	50.0	50.5	50.5
	150	260	310	57.0	57.0	58.0	60.0
	200	320	320	65.0	65.0	67.0	72.5
	300	435	340	83.6	83.1	88.6	104.6

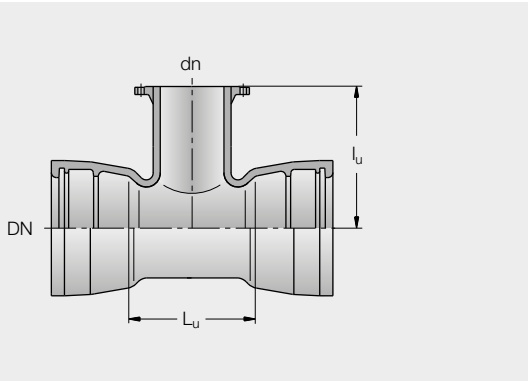
1) In accordance with company standard



DN	dn	Dimensions [mm]		Weight ~ [kg]			
		Lu	lu	PN10	PN16	PN25	PN40
350	100	205	330	59.3	59.3	59.3	59.8
	200	325	350	77.2	76.7	79.2	84.2
	350	495	380	106.0	109.6	117.6	138.6
400	80	185	355	67.8	67.8	67.8	67.8
	100	210	360	71.4	71.4	71.9	71.9
	150	270	370	81.4	81.4	82.4	82.4
	200	325	380	91.1	90.6	92.6	98.1
	300	440	400	113.5	113.5	118.5	134.5
	400	560	420	135.6	140.6	152.6	185.6
500	80 [1]	215	415	103.0	103.0	103.0	103.0
	100	215	420	104.0	104.0	104.0	104.0
	150 [1]	330	430	126.0	126.0	128.0	128.0
	200	330	440	127.9	127.9	129.9	134.9
	250 [1]	450	450	157.0	156.0	161.0	173.0
	300 [1]	450	460	156.7	155.7	161.7	176.7
	350 [1]	565	470	182.0	188.0	199.0	230.0
	400	565	480	182.5	188.5	199.5	233.5
	500	680	500	212.1	227.1	239.1	273.1
600	80 [1]	340	475	163.0	163.0	163.0	163.0
	100 [1]	340	480	164.0	164.0	165.0	165.0
	150 [1]	340	490	166.0	166.0	167.0	168.0
	200	340	500	168.5	168.5	170.5	175.5
	250 [1]	570	510	224.0	224.0	228.0	238.0
	300 [1]	570	520	230.0	230.0	235.0	251.0
	350 [1]	570	530	233.0	236.0	245.0	266.0
	400	570	540	233.3	239.3	250.3	284.3
	500 [1]	800	560	303.0	317.0	327.0	361.0
	600	800	580	308.7	335.7	349.7	401.7

1) In accordance with company standard

5.3 TYTON MMA FITTINGS
Double socket pieces with flanged branch

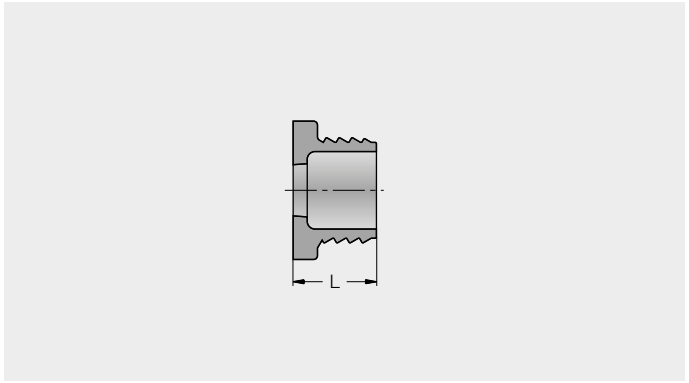


DN	dn	Dimensions [mm]		Weight ~ [kg]			
		Lu	lu	PN10	PN16	PN25	PN40
700	80 [1]	345	505	250.0	250.0	250.0	
	100 [1]	345	510	250.0	250.0	250.0	
	150 [1]	345	520	262.0	262.0	263.0	
	200	345	525	255.3	255.3	257.3	
	300 [1]	575	540	327.0	327.0	343.0	–
	400	575	555	386.7	392.7	403.7	
	500 [1]	925	570	432.0	446.0	480.0	
	600 [1]	925	585	457.0	481.0	502.0	
	700	925	600	481.0	496.0	531.0	
800	100 [1]	350	570	325.0	325.0	326.0	
	150 [1]	303	580	316.0	316.0	318.0	
	200	350	585	316.9	316.9	318.9	
	250 [1]	360	585	350.0	349.0	352.0	
	300 [1]	580	600	417.0	417.0	422.0	–
	400	580	615	405.4	411.4	422.4	
	500 [1]	1045	630	590.0	605.0	617.0	
	600	1045	645	579.0	606.0	620.0	
	800	1045	675	612.0	611.0	680.0	
900	100 [1]	355	630	451.0	451.0	452.0	
	150 [1]	355	640	443.0	443.0	444.0	
	200 [1]	355	645	453.5	453.5	455.5	
	250 [1]	590	655	474.0	474.0	477.0	
	300 [1]	590	660	561.0	561.0	561.0	–
	400	590	675	560.0	565.0	577.0	
	500 [1]	1170	690	813.0	827.0	861.0	
	600	1170	705	810.5	837.5	851.5	
	900	1170	750	921.0	969.0	1090.0	
1000	200	360	705	556.0	556.0	558.0	
	250 [1]	400	705	520.0	519.0	522.0	
	300 [1]	595	720	670.0	670.0	675.0	
	400	595	735	679.5	685.0	696.5	
	600	1290	765	1029.0	1056.0	1070.0	–
	800 [1]	1290	795	1044.0	1063.0	1112.0	
	900 [1]	1290	810	1128.0	1147.0	1196.0	
	1000	1290	825	1149.0	1139.0	1217.0	

1) In accordance with company standard

5.3 THREADED RINGS FOR P FITTINGS

In accordance with company standard

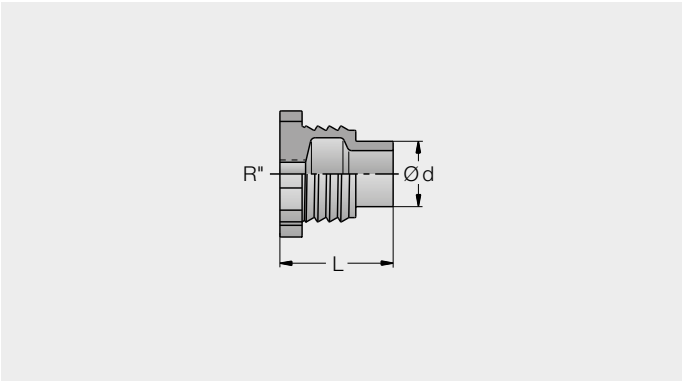


DN	Joint	Dimensions [mm] L	Max. PFA [bar]	Weight ~ [kg]
40	SMU	65	16	1.6
50		67		1.8
80		72		2.9
100		75		3.4
125		78		4.4
150		81		5.5
200		86		9.0
250		92		13.0
300		94		17.5

5.3 PX FITTINGS

Screw plugs for screw sockets

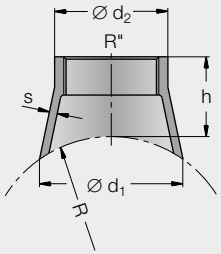
In accordance with company standard



DN	Joint	Dimensions [mm] L	d	R	Max. PFA [bar]	Weight ~ [kg]
40	SMU	97	56	¾"-2"	16	2

5.3 MISCELLANEOUS – WELD-ON CONNECTION PIECES FOR DUCTILE CAST-IRON PIPES

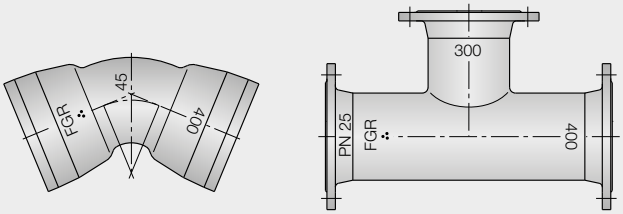
Straight spigots with internal thread



Nominal connection size R"	Radius R	For nominal pipe values DN	Dimensions [mm] Ø d1	Ø d2	s	h	Weight ~ [kg]
2"	98	150-200	90	71	8	50	0.7

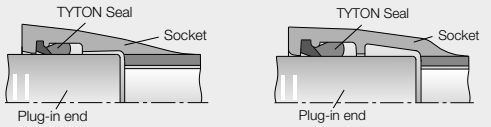
R must be adapted for other nominal pipe sizes (DN)

5.3 Labelling of fittings



All fittings manufactured by member companies of the "Fachgemeinschaft Gussrohrsysteme/European Association for Ductile Iron Pipe Systems (FGR/EADIPS)" bear the "FGR" mark – an expression of compliance with all guidelines for obtaining the "FGR quality seal". In addition, the fittings are marked with the nominal size and the elbows are marked with the respective centring angle. For flange fittings, the nominal pressures 16, 25 and 40 are cast on or stamped on. Flange fittings for PN 10 and all socket fittings do not have a nominal pressure specification. To identify the material as "ductile cast iron", the fittings have three raised dots arranged in a triangle (∴) on the outer surface. Additional markings can be stipulated in special cases.

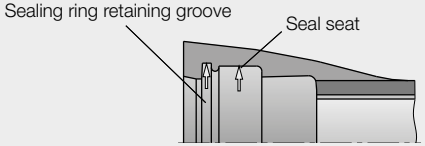
A list of full members of the FGR/EADIPS can be found at
https://eadips.org/eadips/mitglieder/



DN 80 to DN 600 DN 700 to DN 1000 (long socket)

Scope of application
These installation instructions apply to pipes, fittings and valves made of ductile cast iron according to EN 545 and EN 28 650, with a TYTON push-in socket joint according to EN 28 603. Special installation instructions are available for the installation and fitting of longitudinal positive locking joints (BLS and BRS) and/or pipes with a cement mortar coating (CMC). For recommendations for transport, storage and installation, see Chapter 9. For laying tools and equipment, see Chapter 8.

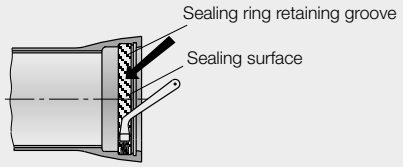
Note: Before using non-positive locking joints in culvert pipes, bridge pipelines and exposed pipes, as well as before installation on steep slopes, in protective pipes and collectors or under unstable ground conditions, our Application Technology department should always be consulted.



Cleaning
The surfaces marked with an arrow on the seal seat and retaining groove for the seal must be cleaned, and any accumulations of paint must be removed. To clean the retaining groove, use a scraper, e.g a bent screwdriver.

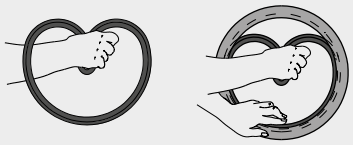
Clean the spigot end up to the line marking. Remove dirt and any colour residues. Carefully and thinly coat only the hatch-marked sealing surface with the lubricant supplied by the pipe manufacturer.

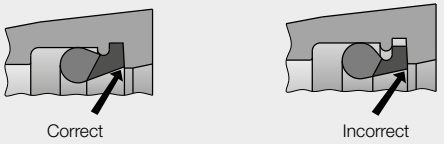
Note: Do not apply lubricant to the retaining groove (narrow chamber).
In hot, dry weather (summer), do not apply the lubricant until immediately before installation, otherwise it may dry out. In cold weather (winter), keep the lubricant and seal warm until shortly before use. This makes installation much easier.



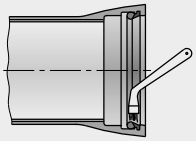
Assembly of the joint
Inserting the TYTON seal.

Clean the seal and press it together in a heart shape.
Insert the seal into the socket so that the retaining part (harder rubber part of the TYTON seal) engages completely in the retaining groove of the socket. Then press the loop flat.



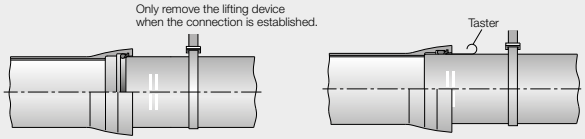


If it is difficult to press the loop flat, pull a second loop on the opposite side. These two small loops can then easily be pressed flat. The inner hard rubber edge of the seal must not stick out over the centring collar.



Apply a thin layer of lubricant to the installed seal. In hot, dry weather (summer), do not apply the lubricant until immediately before installation, otherwise it may dry out. In cold weather (winter), keep the lubricant warm until shortly before use. This makes installation much easier.

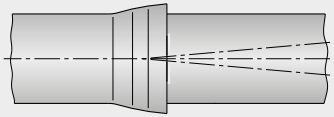
Apply a thin layer of lubricant to the spigot end – especially at the chamfer – and then insert it into the socket until it is centred on the seal. The axes of the horizontal pipe or fitting and the pipe or fitting to be pulled in must form a straight line.



Push the spigot end into the socket until the first marking line is no longer visible.

After producing the joint, check the fit of the seal around the entire circumference using the button. When doing so, you should penetrate into the gap between the spigot end and the front face of the socket at a uniform depth over the entire circumference. If it is possible to penetrate deeper at one or more points, then it is possible that the seal has been pushed out of the retaining groove at these points and that there are therefore leaks. In this case, the joint must be dismantled and the seal seat must be checked.

Bending
Once the joint has been completed, pipes and fittings can be bent:
Up to DN 300 – maximum 5° / DN 400 – maximum 4° / DN 1000 – maximum 3°



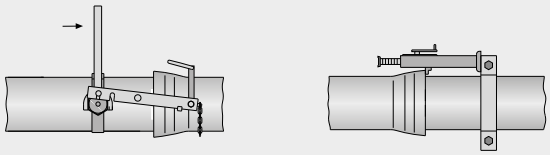
1° deflection results in a deviation of approx. 10 cm from the axis of the previously installed pipe or fitting over a pipe length of 6 m; *e.g. at 3° = 30 cm.*

Cutting pipes to length
Ensure that the pipes can be cut. Shortened pipes must be chamfered at the cut surfaces to match the original spigot ends.

Chamfering must be carried out according to the sketch. The cut surface must be repainted with a coating approved for drinking water. Transfer the line markings from the original spigot end to the cut spigot end.

5.4 TYTON installation instructions

Push-in socket joint



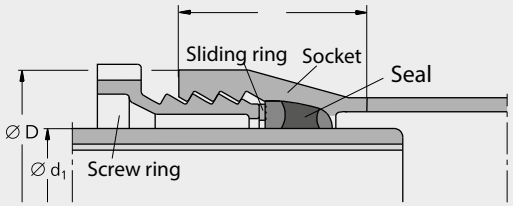
With a laying tool

With a clamp and using a rack jack

Disassembly

Newly installed pipes and fittings can – if necessary – be disassembled without special equipment. To do this, use the laying tool or just move the pipe or fitting back and forth slightly under tension. Pipes with TYTON push-in socket joints that have already been in place for some time can be disassembled as follows.

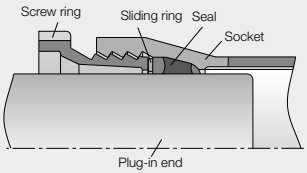
5.5 SCREW SOCKET JOINT
According to EN 28 601



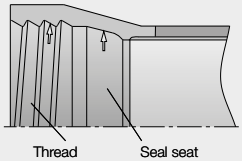
DN	Dimensions [mm]			Weight ~ [kg]			Maximum deflection [°]	PFA [bar]
	Ø d1	ØD	t	Threaded ring	Slide ring	Seal		
80	98	146	84	1.4	0.07	0.12		
100	118	166	88	1.9	0.08	0.15		
125	144	197	91	2.7	0.09	0.19		
150	170	224	94	3.2	0.11	0.23		
200	222	280	100	4.5	0.17	0.36	3	16
250	274	336	106	6.3	0.21	0.50		
300	326	391	110	8.1	0.30	0.66		
350	378	450	113	10.5	0.35	0.84		
400	429	503	116	12.7	0.40	1.05		

PFA: Permissible component operating pressure in bar, may be lower depending on pressure class
PMA = 1.2 × PFA; PEA = 1.2 × PFA + 5

Scope of application
These installation instructions apply to fittings made of ductile cast iron according to EN 545 with a screw socket joint according to DIN 28 601.



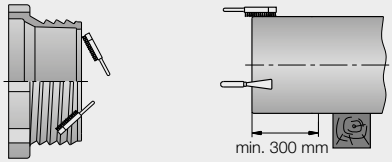
Scope of application
These installation instructions apply to fittings made of ductile cast iron according to EN 545 with a screw socket joint according to EN 28 601. For recommendations for transport, storage and installation, see page 214 et seq. For laying tools and equipment, see Chapter 8.

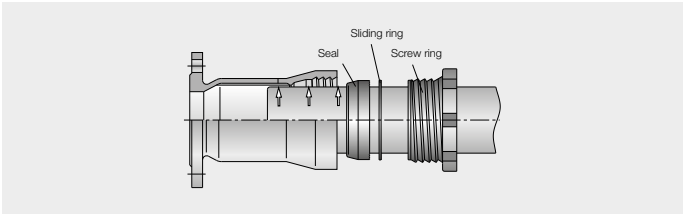


Cleaning
The surfaces marked with an arrow on the seal seat and thread must be cleaned, and any accumulations of paint must be removed. Use a wire brush, for example, to clean the seal seat and the thread.

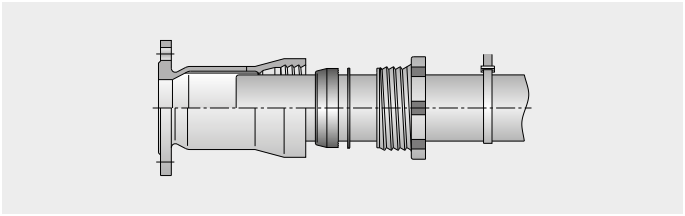
Clean the front pressure-loaded area and thread of the threaded ring thoroughly.

Clean the spigot end to a length of at least 300 mm. Remove impurities and any colour residues.

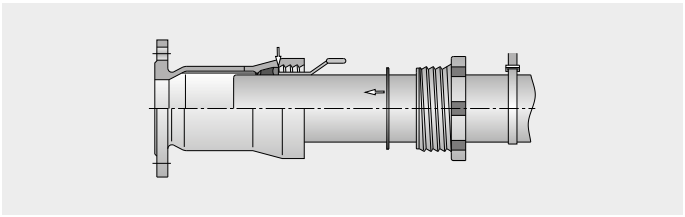




Assembly of the joint
Push the threaded ring, slide ring and seal onto the spigot end in the specified order. Coat the spigot end well with the lubricant supplied by the pipe manufacturer.

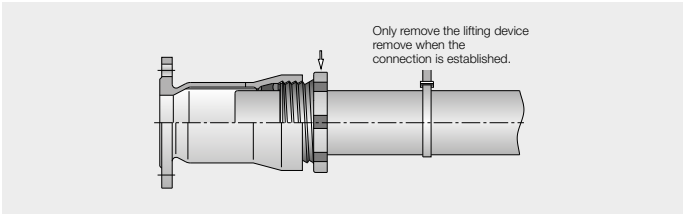


Insert the spigot end into the socket, centre it and check the installation depth.



Press the seal into the sealing chamber with a yarning tool, and push the slide ring forward until it comes into contact with the seal.

5.5 SCREW SOCKET JOINT
According to EN 28 601

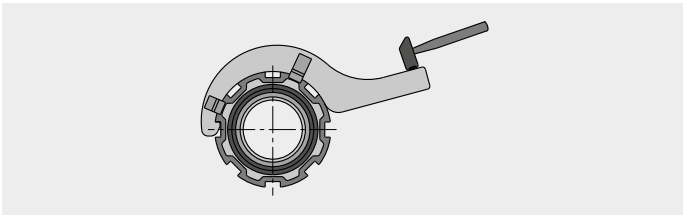


Screw in the threaded ring by hand as far as possible.

Tightening with a hammer up to DN 150

DN	Hammer weight in kg ~
Up to 100	1.5 – 2
Up to 150	2.5 – 3

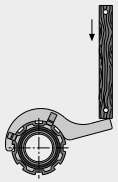
Hook spanner



Tighten the threaded ring with a hammer or ram until the threaded ring no longer rotates. Centre threaded rings from DN 300 when tightening.

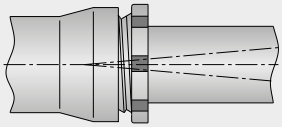
Centring can be done, for example, with two yarning tools, which are to be pushed between the crown of the pipe and threaded ring until there is an even distance between the pipe and the threaded ring all the way round.

5.5 SCREW SOCKET JOINT
According to EN 28 601



Tightening with a wooden ram from DN 200

DN	Wooden ram		
	Length in mm	Cross-section in mm	Weight in kg ~
Up to 300	2250	120 x 120	25
Up to 400	2250	150 x 150	40



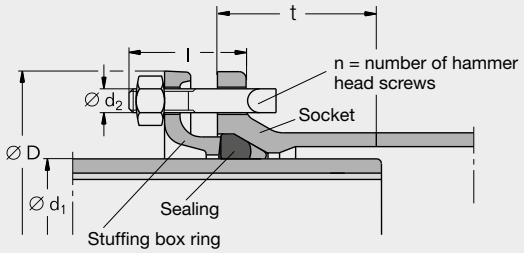
Bending
Once the joint has been completed in a central position, pipes can be bent up to a maximum of 3°.

1° deflection results in a deviation of approx. 10 cm from the axis of the previously installed fitting over a pipe length of 6 m; e.g. at 3° = 30 cm.

Cutting pipes to length
Ensure that the pipes can be cut.

Disassembly
Loosen the threaded ring. Pull the spigot end out of the socket.

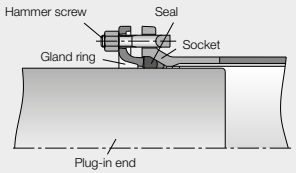
5.6 GLAND NUT SOCKET JOINT
According to EN 28 602



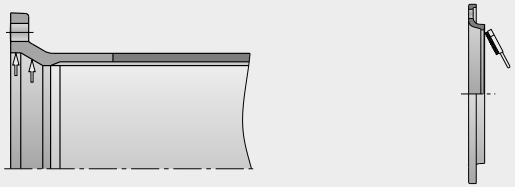
DN	Dimensions [mm]						Weight ~ [kg]			Maximum deflection [°]	PFA [bar]
	Ø d1	Ø D	Ø d2	l	n	t	Gland nut ring	Seal	Hammer head bolt		
400	429	570	M 20	90	12	132	10.6	0.8	5.5	3	16
500	532	680	M 20	100	16	138	15.0	1.1	7.7		
600	635	790	M 20	100	16	143	20.9	1.5	7.7	2	
700	738	900	M 20	110	20	149	27.2	1.9	10.0		
800	842	1010	M 20	110	24	154	34.1	2.3	12.0	1.5	
900	945	1125	M 20	120	24	160	44.0	2.9	12.5		
1000	1048	1250	M 24	120	24	165	56.9	3.5	18.5		

PFA: Permissible component operating pressure in bar, may be lower depending on pressure class
PMA = 1.2 × PFA; PEA = 1.2 × PFA + 5

5.6 GLAND NUT SOCKET JOINT
According to EN 28 602

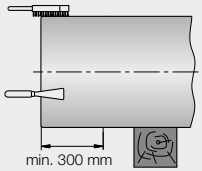


Scope of application
These installation instructions apply to fittings made of ductile cast iron according to EN 545 with a gland nut socket joint according to EN 28 602.



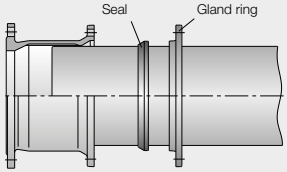
Cleaning
The surfaces marked with an arrow on the seal seat must be cleaned, and any accumulations of paint must be removed. Use a wire brush, for example, to clean the seal seat.

Clean the front pressure-loaded area of the gland nut ring thoroughly.



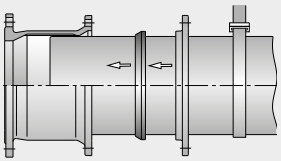
Clean the spigot end to a length of at least 300 mm. Remove impurities and any colour residues.

5.6 GLAND NUT SOCKET JOINT
According to EN 28 602

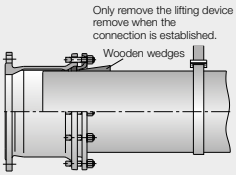


Assembly of the joint
Push the gland nut ring and seal onto the spigot end.

Please note: Do not use lubricant.

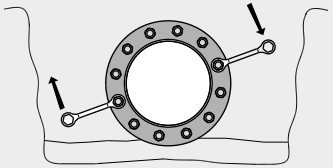


Insert the spigot end into the socket using a lifting device, centre it and check the installation depth. Press the seal into the sealing chamber at a uniform depth.



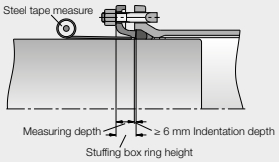
Push the gland nut ring in front of the seal and align it with two hardwood wedges, which can easily be inserted at the top between the gland nut ring and the spigot end. If the gland nut ring is well-centred, subsequent pushing through of the hammer head bolts is easy.

5.6 GLAND NUT SOCKET JOINT
According to EN 28 602



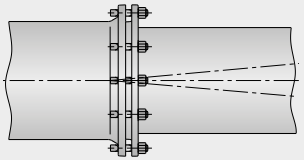
Insert the hammer head bolts into the gland nut flange and gland nut ring. Screw the nuts on evenly by hand as far as possible. For nuts with ring spanners, always tighten two opposite nuts by about half a turn to a full turn each – and do so in sequence.

Correct grouting of the seal has been achieved if the gland nut ring has been pressed into the seal at a depth of at least 6 mm. The press-in depth can be determined by measuring the gland nut ring height and the depth from the outer edge of the gland nut ring to the seal after tightening the bolts. The press-in depth should be as uniform as possible in relation to the respective gland nut socket joint.



At least three measurements are therefore required at each joint. Check the correct installation depth again. Repaint the hammer head bolts and nuts with a standard bitumen varnish.

5.6 GLAND NUT SOCKET JOINT
According to EN 28 602



Bending
Once the joint has been completed in a central position, pipes and fittings can be bent.

Up to DN 500 – maximum 3° / DN 700 – maximum 2° / DN 1000 – maximum 1.5°

1° deflection results in a deviation of approx. 10 cm from the axis of the previously installed pipe or fitting over a pipe length of 6 m;
e.g. at 3° = 30 cm.

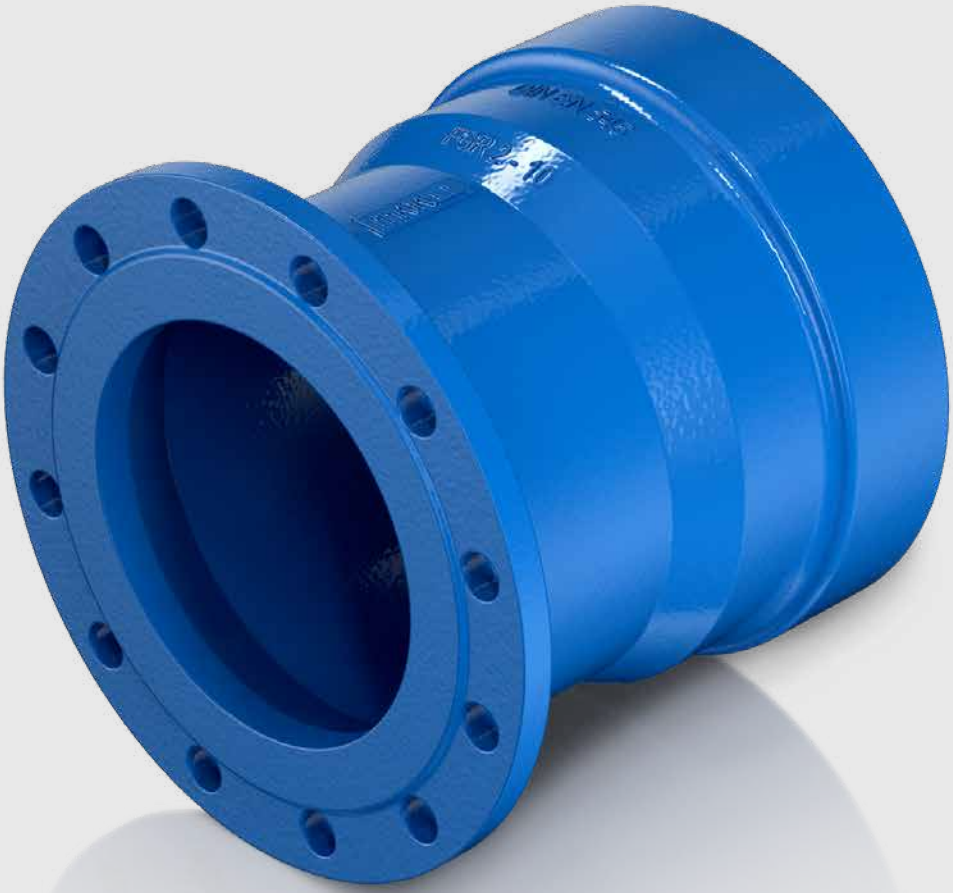
Cutting pipes to length
Ensure that the pipes can be cut.

Disassembly
Loosen the nuts and remove the gland nut ring. Pull the spigot end out of the socket.

6

FLANGE JOINTS

Pipes, fittings and installation instructions



Introduction of FLANGE JOINTS

The flange joints described in this chapter comply with EN 1092-2. The flanges can be cast, screwed or welded on. All flanges with the same DN and the same PN can be combined with each other, regardless of the material. Flange joints of pressure levels PN 10, PN 16, PN 25 and PN 40 are shown below. Flange fittings such as EU and F in PN 63 and PN 100 are also possible.

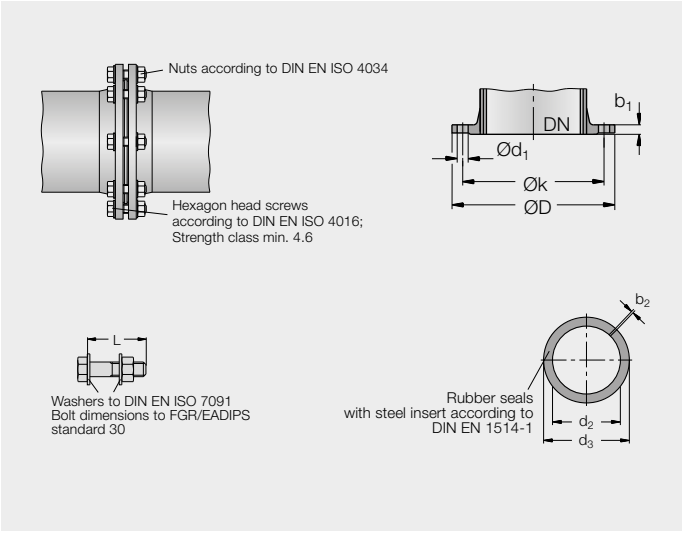
For further information on this, see the technical information:
"DUCTILE CAST-IRON PIPE SYSTEMS for technical snowmaking systems".

Applications/benefits

Flange joints are counted as longitudinal positive locking joints. They are used for aboveground installation and shaft or building installations. Thanks to the standardised hole patterns, they can also be used for the transition between different materials. In the area of underground applications, flanges are mainly used for the installation of shut-off devices.

6.1 PN 10 flange joints

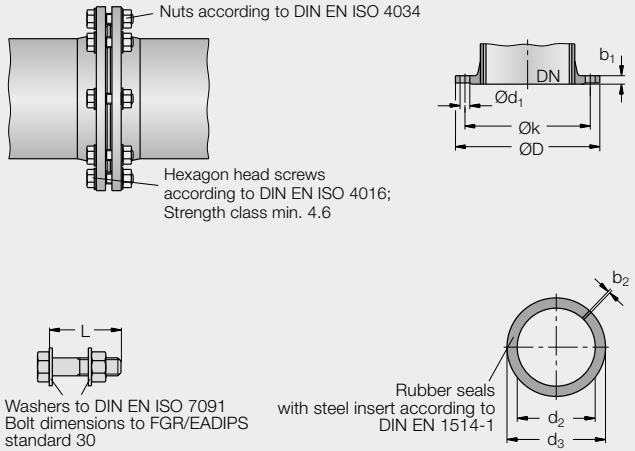
According to EN 1092-2
Bolts, nuts, washers and seals can be obtained from specialist dealers.



DN	Dimensions [mm]							Bolts		
	Flanges				Seal					
	Ø D	b1	Ø k	Ø d1	d2	d3	b2	Quantity	Thread	L
	DN 40 to DN 150 corresponds to PN 16									
200	340	20.0	295	23	220	273	6	8	M 20	80
250	400	22.0	350	23	273	328	6	12	M 20	90
300	455	24.5	400	23	324	378	6	12	M 20	90
350	505	24.5	460	23	368	438	7	16	M 20	90
400	565	24.5	515	28	420	489	7	16	M 24	100
500	670	26.5	620	28	520	594	7	20	M 24	100
600	780	30.0	725	31	620	695	7	20	M 27	110
700	895	32.5	840	31	720	810	8	24	M 27	120
800	1015	35.0	950	34	820	917	8	24	M 30	120
900	1115	37.5	1050	34	920	1017	8	28	M 30	130
1000	1230	40.0	1160	37	1025	1124	8	28	M 33	140

6.1 PN 16 flange joints

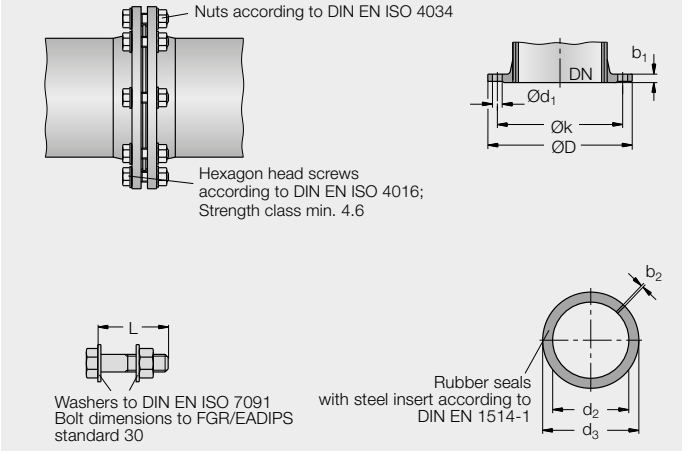
According to EN 1092-2
Bolts, nuts, washers and seals can be obtained from specialist dealers.



DN	Dimensions [mm]							Bolts		
	Flanges				Seal					
	Ø D	b1	Ø k	Ø d1	d2	d3	b2	Quan-tity	Thread	L
DN 40 to DN 80 corresponds to PN 25										
100	220	19.0	180	19	115	162	5	8	M 16	80
125	250	19.0	210	19	141	192	5	8	M 16	80
150	285	19.0	240	23	169	218	5	8	M 20	80
200	340	20.0	295	23	220	273	6	12	M 20	80
250	400	22.0	355	28	273	329	6	12	M 24	90
300	455	24.5	410	28	324	384	6	12	M 24	100
350	520	26.5	470	28	368	444	7	16	M 24	100
400	580	28.0	525	31	420	495	7	16	M 27	110
500	715	31.5	650	34	520	617	7	20	M 30	120
600	840	36.0	770	37	620	734	7	20	M 33	130
700	910	39.5	840	37	720	804	8	24	M 33	140
800	1025	43.0	950	41	820	911	8	24	M 36	150
900	1125	46.5	1050	41	920	1011	8	28	M 36	160
1000	1255	50.0	1170	44	1025	1128	8	28	M 39	170

6.1 PN 25 flange joints

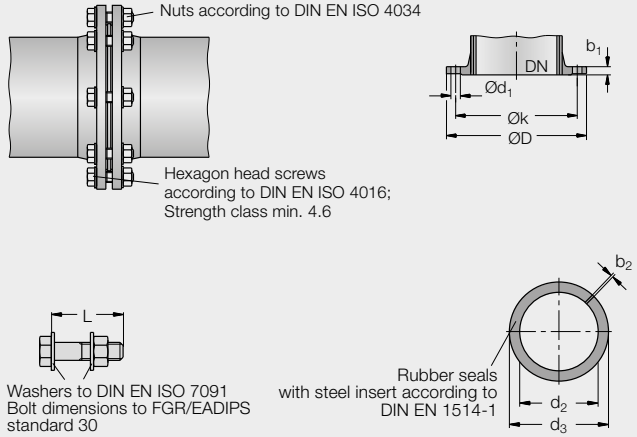
According to EN 1092-2
Bolts, nuts, washers and seals can be obtained from specialist dealers.



DN	Dimensions [mm]							Bolts		
	Flanges				Seal					
	Ø D	b1	Ø k	Ø d1	d2	d3	b2	Quan-tity	Thread	L
DN 40 to DN 100 corresponds to PN 40										
125	270	19.0	220	28	141	194	4.5	8	M 24	90
150	300	20.0	250	28	169	224	5.0	8	M 24	90
200	360	22.0	310	28	220	284	6.0	12	M 24	90
250	425	24.5	370	31	273	340	6.0	12	M 27	110
300	485	27.5	430	31	324	400	6.0	16	M 27	110
350	555	30.0	490	34	368	457	7.0	16	M 30	110
400	620	32.0	550	37	420	514	7.0	16	M 33	120
500	730	36.5	660	37	520	624	7.0	20	M 33	130
600	845	42.0	770	40	620	731	7.0	20	M 36	150
700	960	46.5	875	43	720	833	8.0	24	M 39	160
800	1085	51.0	990	49	820	942	8.0	24	M 45	180
900	1185	55.5	1090	49	920	1042	8.0	28	M 45	180
1000	1320	60.0	1210	56	1025	1154	8.0	28	M 52	200

6.1 PN 40 flange joints

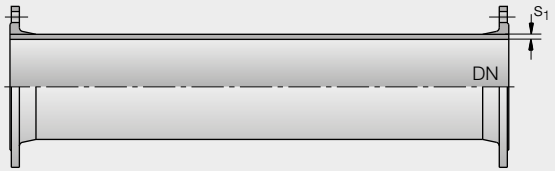
Bolts, nuts, washers and seals
can be obtained from specialist dealers.



DN	Dimensions [mm]							Bolts		
	Flanges				Seal					
	Ø D	b1	Ø k	Ø d1	d2	d3	b2	Quan-tity	Thread	L
40	150	19.0	110	19	49	92	5.5	4	M 16	70
50	165	19.0	125	19	61	107	5.5	4	M 16	70
65	185	19.0	145	19	77	127	5.5	8	M 16	70
80	200	19.0	160	19	89	142	5.5	8	M 16	80
100	235	19.0	190	23	115	168	8.0	8	M 20	80
125	270	23.5	220	28	141	194	8.0	8	M 24	90
150	300	26.0	250	28	169	224	8.0	8	M 24	100
200	375	30.0	320	31	220	290	8.0	12	M 27	110
250	450	34.5	385	34	273	352	8.0	12	M 30	120
300	515	39.5	450	34	324	417	8.0	16	M 30	130
350	580	44.0	510	37	368	474	8.0	16	M 33	150
400	660	48.0	585	41	420	546	8.0	16	M 36	160
500	755	52.0	670	44	520	628	10.0	20	M 39	170
600	890	58.0	795	50	620	747	10.0	20	M 45	190

6.2 Flanged pipes made from ductile cast iron FF pipes, PN 10, PN 16 and PN 25

With integral flange (type 21) according to EN 1092-2

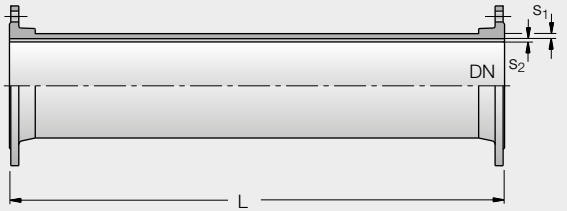


DN	Dimensions [mm]			Weight ~ [kg]			
	[mm]		[m]		Of a flange		
	d1	s1	Construction length	1 m pipe without flange	PN 10	PN 16	PN 25
80	98	7.0	0.1 - 2.0	16.1	2.8	2.8	2.8
100	118	7.2		20.4	3.3	3.3	3.8
125	144	7.5		26.4	4.0	4.0	4.7
150	170	7.8		32.4	5.0	5.0	6.0
200	222	8.4		46.1	6.9	6.7	8.7
250	274	9.0	0.1 - 3.0	61.3	9.8	9.4	13.0
300	326	9.6		78.1	13.0	12.6	17.7
350	378	10.2	0.2 - 3.0	96.5	14.7	17.5	25.4
400	429	10.8		116.2	17.2	22.1	33.2
500	532	12.0		160.6	23.2	37.4	47.2
600	635	13.2		211.3	32.8	57.6	68.0
700	738	14.4	0.3 - 2.0	268.5	44.3	57.4	–
800	842	15.6	0.4 - 2.0	332.1	58.5	76.8	–
900	945	16.8	0.4 - 3.0	401.7	69.6	91.4	–
1000	1048	18.0		477.7	87.6	127.0	–

Separating FF pipes with an integral flange is not recommended.
Outside: Epoxy resin according to EN 14 901
Inside: Epoxy resin according to EN 14 901

6.2 Flanged pipes made from ductile cast iron
FF pipes, PN 10, PN 16 and PN 25

According to EN 545
With threaded flange (type 13) according to EN 1092-2



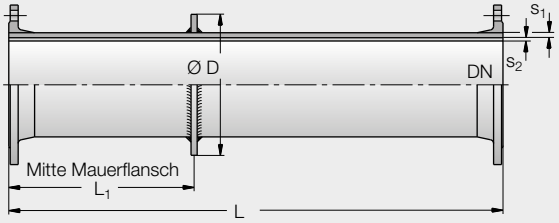
DN	Dimensions [mm]				Weight ~ [kg]				
	[mm]			[m]	1 m pipe without flange		Of a flange		
	d1	s1	s2	Installation length	ZMA	Cast iron	PN 10	PN 16	PN 25
80	98	6.0			2.0	12.2	3.3	3.3	3.3
100	118	6.0			2.5	14.9	3.8	3.8	4.6
125	144	6.2			3.1	18.9	4.8	4.8	5.7
150	170	7.8	4	0.7 - 5.8	3.7	28.0	6.0	6.0	8.6
200	222	8.4			4.9	39.8	8.2	8.0	10.2
250	274	9.0			6.1	52.8	11.6	11.6	15.1
300	326	11.2			7.3	78.1	15.1	15.1	20.1
350	378	11.9			12.3	96.5	17.7	20.4	27.9
400	429	12.6	5	0.7 - 4.0	14.0	116.3	21.0	25.5	36.4
500	532	14.0			17.5	160.6	31.0	47.0	–
600	635	15.4			20.9	211.3	42.7	66.2	–

Only cut FF pipes after checking the external diameter.

Outside: Zinc coating with finishing layer
Inside: Cement mortar lining or PUR

6.2 Flanged pipes made from ductile cast iron
FF pipes, PN 10, PN 16 and PN 25

According to EN 545
With puddle flange in accordance with company standard



DN	Dimensions [mm]			Weight ~ [kg]		
	Dia. D			Of a puddle flange		
	PN 10	PN 16	PN 25	PN 10	PN 16	PN 25
80	140	140	140	0.7	0.7	0.7
100	160	160	160	0.8	0.8	0.8
125	190	190	190	1.0	1.0	1.0
150	230	230	230	1.5	1.5	1.5
200	300	300	300	3.0	3.0	3.0
250	320	320	370	1.7	1.7	5.7
300	380	380	430	2.3	2.3	8.2
350	440	440	500	3.1	3.1	13.1
400	500	500	530	4.9	4.9	10.4
500	620	620	650	8.8	8.8	–
600	740	740	780	15.1	15.1	–

Larger DN and PN on request; Specify the following when placing the order: L, L1, design as single-flange piece, dia.D deviating from the table; Puddle flanges are also available as segments that can be fusion-welded on the construction site. Concrete quality at least C 20/25, setting time of three days

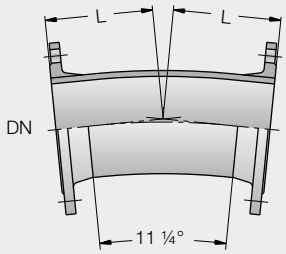
Only cut FF pipes after checking the external diameter.

Outside: Zinc coating with finishing layer, puddle flange, untreated
Inside: Cement mortar lining

6.3 FLANGE FITTINGS – FFK FITTINGS 11

11¼° double flange elbows

In accordance with company standard

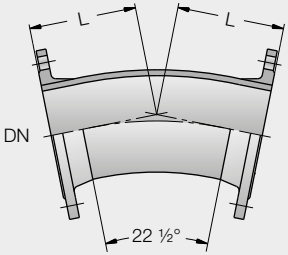


DN	Dimensions [mm]	Weight ~ [kg]			
	L	PN10	PN16	PN25	PN40
80	130	9.5	9.5	9.5	9.5
100	140	11.9	11.9	12.9	12.9
125	150	15.3	15.3	17.3	20.5
150	160	19.0	19.0	21.5	25.5
200	180	26.0	25.0	29.5	39.0
250	210	41.5	41.0	48.0	65.5
300	255	60.0	59.5	69.5	96.5
350	105	56.0	61.5	77.0	135.9
400	113	58.0	67.5	90.0	165.3
500	135	85.0	113.0	134.0	232.8
600	174	157.0	202.0	223.0	253.2
700	194	243.0	269.0	299.0	–
800	213	330.0	366.0	333.0	–

6.3 FFK FITTINGS 22

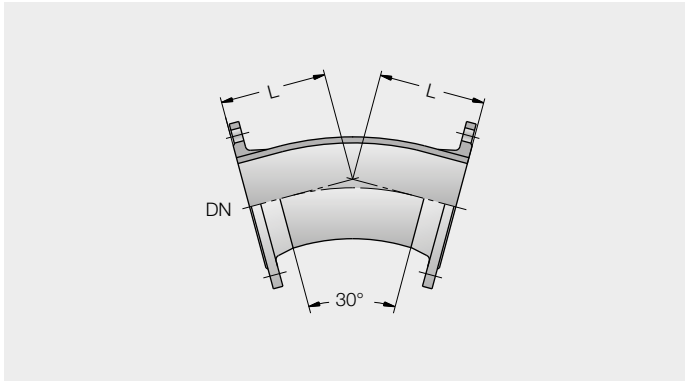
22½° double flange elbows

In accordance with company standard



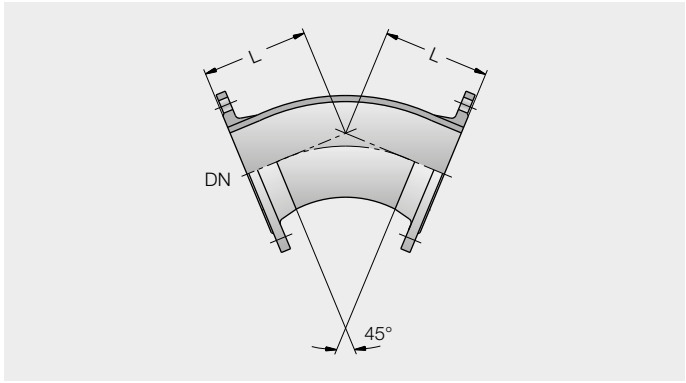
DN	Dimensions [mm]	Weight ~ [kg]			
	L	PN10	PN16	PN25	PN40
80	130	9.5	9.5	9.5	9.5
100	140	11.9	11.9	12.9	12.9
125	150	15.3	15.3	17.8	20.5
150	160	19.7	19.7	21.5	25.5
200	180	29.0	27.5	32.5	42.0
250	210	41.5	41.0	48.0	65.5
300	255	60.0	59.0	69.5	96.5
350	140	58.0	64.0	81.0	128.0
400	153	67.0	75.5	98.0	156.5
500	185	99.0	127.0	148.0	232.0
600	254	182.0	227.0	248.0	350.0
700	284	313.0	339.0	334.0	–
800	314	428.0	646.0	445.0	

6.3 FFK FITTINGS 30
30° double flange elbows
In accordance with company standard



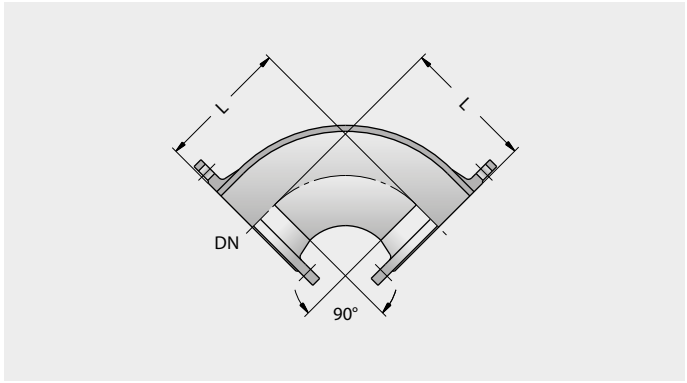
DN	Dimensions [mm]	Weight ~ [kg]			
	L	PN10	PN16	PN25	PN40
80	130	9.5	9.5	9.5	9.5
100	140	11.9	11.9	12.9	12.9
125	150	15.3	15.3	17.8	20.5
150	160	19.5	19.5	19.5	25.0
200	180	29.0	27.5	32.5	42.0
250	210	41.5	40.5	48.0	65.0
300	255	59.5	59.0	69.0	96.0
350	165	65.0	71.0	88.0	138.0
400	183	73.0	82.5	106.0	163.5
500	220	109.0	137.0	158.0	256.0
600	309	212.0	257.0	278.0	284.0
700	346	360.0	386.0	430.0	–
800	383	493.0	529.0	674.0	

6.3 FFK FITTINGS 45
45° double flange elbows
According to EN 545



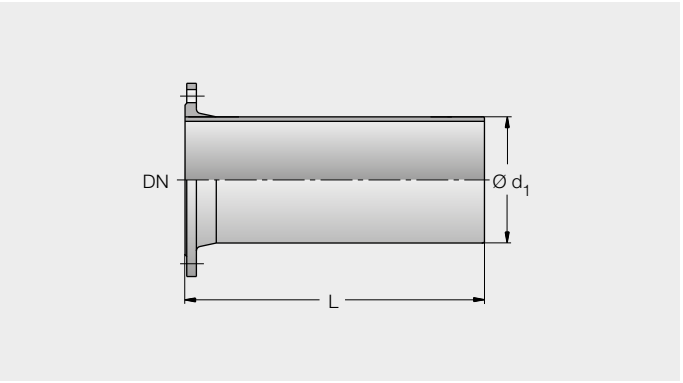
DN	Dimensions [mm]	Weight ~ [kg]			
	L	PN10	PN16	PN25	PN40
80	130	9.4	9.4	9.4	9.4
100	140	11.3	11.3	12.3	12.3
125	150	14.5	14.5	15.7	18.3
150	160	18.4	18.4	20.5	24.5
200	180	27.5	27.0	31.0	41.5
250	350	54.5	54.0	61.5	82.0
300	400	77.2	76.2	87.7	118.2
350	298	75.5	82.0	99.0	141.0
400	324	94.4	106.4	128.4	196.4
500	375	143.5	173.5	196.5	264.5
600	426	210.0	263.0	292.0	397.0
700	478	292.5	322.5	392.5	
800	529	399.5	437.5	535.5	–
900	581	513.0	561.0	682.0	
1000	632	661.0	744.0	899.0	

6.3 Q FITTINGS
90° double flange elbows
According to EN 545

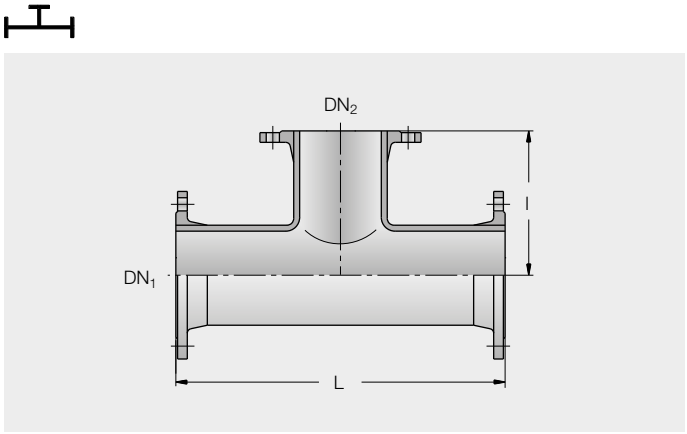


DN	Dimensions [mm]	Weight ~ [kg]			
	L	PN10	PN16	PN25	PN40
80	165	9.7	9.7	9.7	9.7
100	180	12.3	12.3	12.3	12.3
125	200	18.0	18.0	21.1	22.3
150	220	19.8	19.8	21.8	26.3
200	260	31.2	30.2	34.7	45.2
250	350	50.0	49.0	57.0	77.0
300	400	69.9	68.9	80.4	110.9
350	450	93.1	102.2	146.0	190.0
400	500	133.2	146.2	205.5	272.5
500	600	179.0	209.0	233.0	300.0
600	700	269.0	322.0	350.0	455.0
700	800	381.5	411.5	481.5	–
800	900	527.0	565.5	664.5	
900	1000	690.0	737.0	858.0	
1000	1100	896.0	979.0	1135.0	

6.3 F FITTINGS
Single-flange fittings
According to EN 545

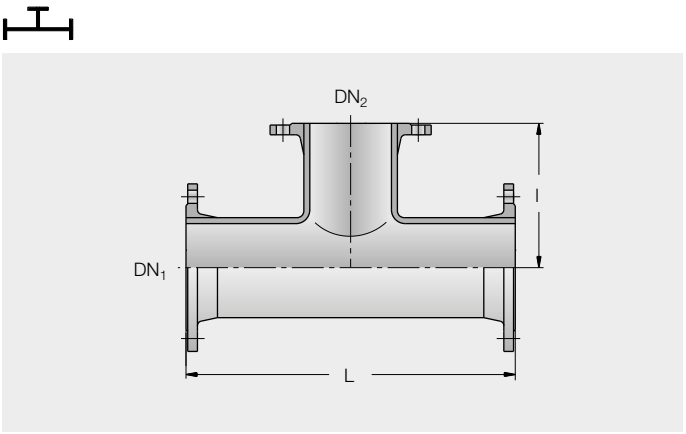


DN	Dimensions [mm]		Weight ~ [kg]			
	L	d1	PN10	PN16	PN25	PN40
80	350	98	7.5	7.5	7.5	7.5
100	360	118	8.5	8.5	10.4	10.4
125	370	144	12.4	12.4	13.1	14.3
150	380	170	15.6	15.6	16.6	17.5
200	400	222	24.6	24.0	24.5	29.0
250	420	274	32.0	31.5	36.0	45.0
300	440	326	43.2	42.7	47.7	63.2
350	460	378	52.3	55.3	64.3	85.3
400	480	429	64.3	70.3	81.3	115.0
500	520	532	93.9	109.0	121.0	154.0
600	560	635	133.0	159.0	173.0	226.0
700	600	738	179.0	194.0	228.0	–
800	600	842	226.0	245.0	294.0	
900	600	945	272.0	295.0	356.0	
1000	600	1048	328.0	369.0	447.0	



DN1	DN2	Dimensions [mm] Version 1 Lv1	lv1	Version 2 Lv2	lv2	Weight ~ [kg] V1/V2 PN10	V1/V2 PN16	V1/V2 PN25	V1/V2 PN40
80	40[1]	330	155	330	160	14.7/14.5	14.7/14.5	14.7/14.5	14.7/14.5
	50		160		160	15.7/14.2	15.7/14.2	15.7/14.2	15.7/14.2
	80		165		165	17.0/15.6	17.0/15.6	17.0/15.6	17.0/15.6
100	40[1]	360	170	360	170	17.8/18.0	17.8/18.0	17.2/19.0	17.2/19.0
	50				170	18.7/17.1	18.7/17.1	22.7/18.1	22.7/18.1
	80		175		175	20.2/18.4	20.2/18.4	24.5/19.6	24.5/19.6
	100		180		180	21.3/19.0	21.3/19.0	22.0/20.5	22.0/20.5
125	80	400	190	400	190	25.4/22.8	25.4/22.8	30.0/24.3 *	26.0/26.8 *
	100		195		195	27.0/23.8	27.0/23.8	26.0/25.8 *	28.5/28.3 *
	125		200		200	28.1/25.2	28.1/25.2	32.5/26.7	31.0/30.7
150	80	440	205	440	205	31.9/28.5	31.9/28.5	41.6/30.5	45.9/35.0
	100		210		210	32.4/29.4	32.4/29.4	42.1/31.9	35.5/35.9
	125		215		215	34.6/30.9	34.6/30.9	33.5/33.4 *	38.0/38.9 *
	150		220		220	32.2/32.3	36.2/32.3	49.1/35.3	58.3/41.9
200	80	520	235	520	235	47.4/42.2	47.4/41.7	57.5/45.7	68.5/56.7
	100		240		240	47.5/43.1	47.5/42.6	58.5/47.1	75.1/57.6
	125		245		245	50.0/51.0	50.0/51.0	61.0/55.0	73.0/58.0
	150		250		250	51.3/46.0	51.3/45.5	54.0/50.5	80.0/63.0
	200		260		260	51.8/49.5	51.8/48.5	77.5/55.0	94.0/70.5
250	080[1]	700	265	700	265	74.0/66.5	74.0/66.0	78.0/74.0	114.0/95.0
	100		275		275	75.0/67.6	75.0/66.6	103.0/75.1	123.1/95.2
	125		280		275	75.0/92.0	75.0/91.0	75.5/100.0	95.5/121.0
	150[1]		300		300	78.3/72.0	78.3/71.5	110.7/79.5	128.5/100.5
	200		325		325	88.7/76.0	88.7/75.5	94.0/83.5	119.0/104.5
	250		350		350	91.8/81.0	91.8/81.0	121.0/88.5	130.0/109.5
300	080[1]	800	290	800	290	120.6/96.5	120.6/95.5	108.0/108.0 *	142.0/142.0 *
	100		300		300	104.2/98.5	104.2/97.5	158.0/104.8 *	143.0/135.8 *
	150[1]		325		325	108.0/101.0	108.0/100.0	116.0/112.0 *	179.5/145.0 *
	200		350		350	114.0/102.4	114.0/101.4	130.0/114.4 *	164.0/151.4 *
	250[1]		375		400	121.0/113.9	121.0/112.9	129.0/128.9 *	174.0/175.9 *
	300		400		375	131.0/114.0	131.0/113.0	194.0/128.0 *	188.0/168.0 *

1) Version 1 in accordance with company standard; * Version 2 on request



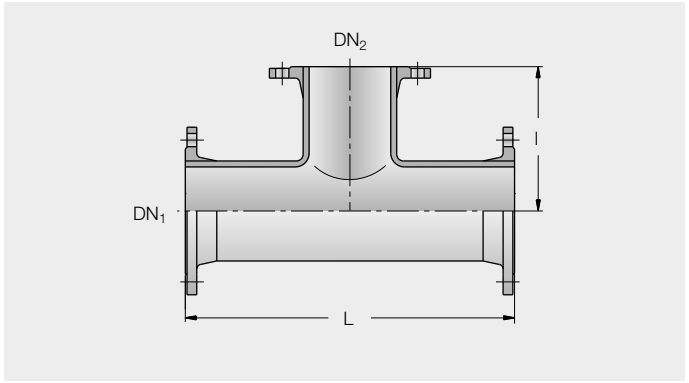
DN1	DN2	Dimensions [mm] Version 1 Lv1	lv1	Version 2 Lv2	lv2	Weight ~ [kg] V1/V2 PN10	V1/V2 PN16	V1/V2 PN25	V1/V2 PN40
350	100	850	325	850	325	130.1/115.5 *	140.4/121.5 *	173.0/138.5 *	183.0/181.5 *
	200		325		325	137.7/120.5 *	149.0/126.5 *	160.0/145.5 *	210.0/193.5 *
	350		425		425	150.6/138.8 *	151.0/147.8 *	192.0/172.8 *	249.0/236.8 *
400	80[1]	900	350	900	350	167.4/141.0	180.4/153.0	186.0/235.0 *	253.0/302.0 *
	100		350		350	170.6/143.0	185.8/155.0	187.0/176.4 *	254.0/244.4 *
	150[1]		350		350	157.0/145.0	169.0/157.0	192.0/241.0 *	262.0/310.0 *
	200		350		350	192.2/165.0	192.2/177.0	213.8/183.3 *	277.0/255.3 *
	300[1]		450		450	196.0/177.0	200.3/191.0	228.0/271.0 *	308.0/354.0 *
	400		450		450	198.5/191.5	225.0/210.0	254.0/219.5	356.0/320.5 *
500	80	1000	400	1000	400	233.5/200.0	234.0/228.0	281.0/260.0 *	348.0/328.0 *
	100		400		400	236.5/208.0	265.0/238.0	305.6/264.5 *	349.0/331.5 *
	150		400		400	243.5/216.0	273.5/252.0	288.0/359.0 *	362.0/428.0 *
	200		400		400	260.3/224.0	291.6/266.0	292.0/269.5 *	362.0/342.5 *
	300[1]		500		500	277.0/245.0	285.0/294.0	305.0/393.0	391.0/476.0 *
	400		500		500	286.2/234.7 *	346.7/270.7 *	356.4/305.7 *	447.0/406.7 *
	500		500		500	311.0/302.5	317.5/350.0	356.6/324.6 *	469.0/425.6 *
600	80	1100	450	1100	450	358.0/304.0 *	389.0/353.0 *	374.0/374.0 *	468.0/478.0 *
	100		450		450	373.7/334.0	408.5/369.0	375.0/518.0 *	469.0/623.0 *
	150[1]		450		450	386.6/336.0	388.0/372.0	380.0/522.0 *	476.0/630.0 *
	200		450		450	319.4/342.0	417.9/378.0	410.0/387.0 *	502.0/497.0 *
	300		550		550	392.0/360.0	440.6/413.0	444.0/553.0 *	530.0/673.0 *
	400		550		550	380.0/374.0	434.0/432.0	507.1/422.0 *	594.0/561.0 *
	500[1]		550		550	395.0/390.0	460.0/456.0	493.0/697.0 *	623.0/746.0 *
	600		550		550	413.0/440.0	513.0/518.0	480.0/465.0 *	659.0/623.0 *
700	100[1]	650	525	650	510	325.0/270.0 *	351.0/296.0 *	473.0/366.0 *	–
	150[1]		525	1200	500	326.0/608.0 *	352.0/638.0 *	474.0/659.0 *	–
	200		525	650	525	355.3/265.9 *	393.1/295.9 *	486.0/366.9 *	–
	300[1]	870	555	870	540	404.0/344.0 *	432.0/370.0 *	524.0/444.0 *	–
	400		555		555	490.9/337.5 *	467.0/372.5 *	566.0/453.5 *	–
	500[1]		600		570	570.8/669.0 *	563.0/714.0 *	675.0/796.0 *	–
	600[1]	1200	600	1200	585	572.4/686.0 *	658.8/743.0 *	704.0/827.0 *	–
	700		600		600	635.0/459.0 *	622.0/504.0 *	726.0/609.0 *	–

1) Version 1 in accordance with company standard; * Version 2 on request

6.3 T FITTINGS

Double flange pieces with a flanged branch

According to EN 545



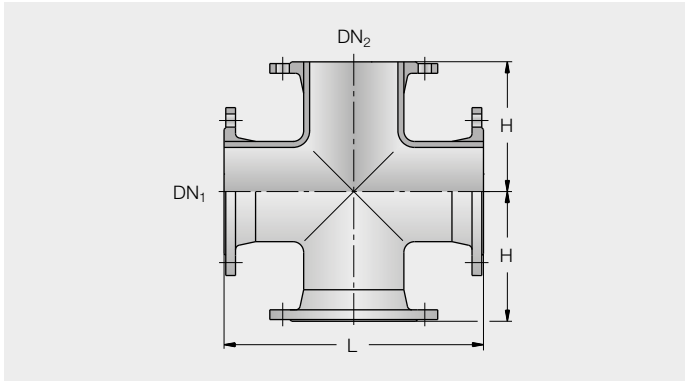
DN1	DN2	Dimensions [mm] Version 1 Lv1	lv1	Version 2 Lv2	lv2	Weight ~ [kg] V1/V2 PN10		V1/V2 PN16		V1/V2 PN25		V1/V2 PN40
800	80[1]			570	–	–	426.5/–		464.5/–		556.5/–		
	100[1]	690		570	690	570	417.5/354.0		471.0/390.0		558.0/528.0	*	
	150[1]			580	690	580	457.2/370.0		428.0/392.0		562.0/476.0	*	
	200			585	690	585	468.7/349.5		475.0/387.5		570.0/487.5	*	
	300[1]	910	600	690	600		574.6/443.0		545.0/478.0		640.0/620.0	*	–
	400	910	615	910	615		583.2/434.0		580.0/478.0		682.0/588.0	*	
	500[1]			645	1350	630	737.6/607.0		738.0/657.0		841.0/795.0	*	
	600	1350		645	1350	645	694.4/599.5		769.0/663.5		872.0/776.5	*	
	700[1]			675	1300	650	719.0/916.0	*	771.0/916.0	*	896.0/1054.0	*	
	800			675	1350	675	756.0/631.5		760.0/689.5		967.0/836.5	*	
900	100[1]	730	640	730	640		702.0/445.0	*	472.0/488.0	*	588.0/730.0	*	
	200	730	645	730	645		455.0/432.0	*	477.0/480.0	*	593.0/603.0	*	
	300[1]	950	660	950	660		544.0/544.0	*	566.0/588.0	*	685.0/690.0	*	
	400	950	675	950	675		552.0/532.5	*	574.0/585.5	*	596.0/717.5	*	–
	500				1500	690	–/784.0	*	–/842.0	*	–/960.0	*	
	600	–	–		1500	705	–/771.0	*	–/846.0	*	–/981.0	*	
	900				1500	750	–/818.0	*	–/890.0	*	–/1071.0	*	
1000	150[1]	770	705	–	–		588.0/–		667.0/–		817.0/–		
	200	770	705	770	705		591.0/541.0	*	670.0/624.0	*	820.0/782.0	*	
	300[1]	990	735	1500	750		681.0/1363.0	*	760.0/1360.0	*	915.0/1516.0	*	
	400	990	735	990	735		693.0/658.0		774.0/746.0		935.0/913.0		
	500[1]				1500	750	1010.0/1396.0		1114.0/1395.0		1284.0/1551.0		–
	600				1650	765	1025.0/9905		1141.0/1099.5		1302.0/1269.5		
	700[1]	1650	825		1500	750	1048.0/1446.0	*	1161.0/1445.0	*	1351.0/1601.0	*	
	800[1]				1500	750	1075.0/1468.0		1182.0/1465.0		1398.0/1621.0	*	
	900[1]				1500	750	1095.0/1464.0	*	1207.0/1460.0	*	1415.0/1616.0	*	
	1000				1650	825	1125.0/1058.5		1245.0/1183.5		1472.0/1416.5	*	

1) Version 1 in accordance with company standard; * Version 2 on request

6.3 TT FITTINGS

Double flange pieces with two flanged branches

In accordance with company standard



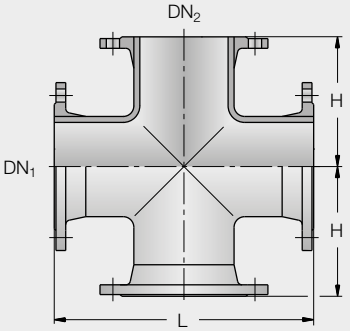
DN1	DN2	Dimensions [mm] L	H	Weight ~ [kg] PN10	PN16
80	80	330	165	23.1	23.1
100	80	360	175	23.8	23.8
	100		180	27.1	27.1
125	100	400	195	35.0	35.0
	125		200	35.2	35.2
150	80	440	205	38.5	38.5
	100		210	41.0	41.0
	125		215	43.4	43.4
	150		220	46.6	46.6
200	80	520	235	45.8	45.8
	100		240	51.6	51.6
	150		250	59.6	59.6
	200		260	68.7	68.7
250	80	700	270	99.0	99.0
	100		275	101.0	101.0
	125		275	103.0	103.0
	150		300	107.0	107.0
	200		325	114.8	114.8
	250		350	119.5	119.5
300	80	800	295	128.0	128.0
	100		300	141.0	141.0
	150		325	145.0	145.0
	200		350	167.0	167.0
	250		375	170.0	170.0
	300		400	196.0	196.0
350	100	850	325	126.5	132.5
	300		425	174.0	180.0
	350		425	193.0	199.0

Higher pressures on request

6.3 TT FITTINGS

Double flange pieces with two flanged branches

In accordance with company standard



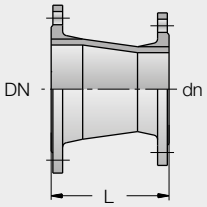
DN1	DN2	Dimensions [mm] L	H	Weight ~ [kg] PN10	PN16
400	80	900	345	148.0	158.0
	100		350	152.0	162.0
	150			157.0	167.0
	200			161.5	172.0
	250			176.0	181.5
	300		450	196.0	209.0
	350			218.0	231.0
	400			252.0	257.0
500	80	1000	400	213.0	241.0
	150			336.0	364.0
	200			339.0	367.0
	250			343.0	371.0
	300		500	373.0	401.0
	400			378.0	411.0
	500			386.0	431.0
600	150	1100	450	309.0	361.0
	200			314.0	364.0
	250			319.0	369.0
	300		550	372.0	422.0
	350			376.0	428.0
	400			381.0	444.0
	500			415.0	478.0
	600			530.0	547.0
700	400	870	555	446.0	482.0
	700	1200	600	658.0	610.0

Higher pressures on request

6.3 FFR FITTINGS

Double flange transition pieces

According to EN 545 and company standard



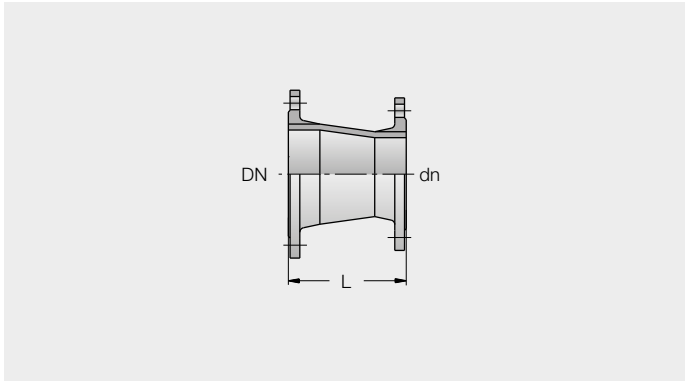
DN1	dn	Dimensions [mm] L	Weight ~ [kg] PN10	PN16	PN25	PN40
80	40 [1]	200	7.8	7.8	7.8	7.8
	50 [1]		7.9	7.9	7.9	7.9
	65 [1]		9.2	9.2	9.2	9.2
100	40 [1]	200	8.9	8.9	9.7	9.7
	50 [1]		9.4	9.4	11.0	11.0
	65 [1]		10.6	10.6	12.6	12.6
	80		11.1	11.1	13.1	13.1
125	40 [1]	200	12.5	12.5	13.5	13.5
	50 [1]		12.6	12.6	14.5	14.5
	65 [1]		13.0	13.0	15.5	15.5
	80 [1]		13.0	13.0	17.5	17.5
	100		13.1	13.1	18.0	18.0
150	40 [1]	300	14.4	14.4	15.4	17.4
	50 [1]		17.4	17.4	18.4	20.4
	65 [1]		17.9	17.9	18.4	21.4
	80 [1]	200	13.9	13.9	15.9	15.9
	100 [1]		15.9	15.9	18.8	20.4
	125		16.4	16.4	18.4	22.4
200	50	300	20.6	20.6	25.1	32.1
	80		22.9	22.9	28.1	34.1
	100		23.8	23.8	29.2	37.5
	125		25.5	25.5	30.9	38.5
	150		26.4	26.4	35.1	39.4
250	80 [1]	300	26.0	29.0	30.5	41.0
	100 [1]		29.0	32.5	33.0	44.0
	125 [1]		31.5	32.5	33.0	46.5
	150 [1]		32.5	33.0	36.6	55.5
	200		34.1	34.1	40.0	56.5
300	100 [1]	300	29.0	29.0	35.0	48.0
	150 [1]		33.0	32.5	38.0	55.0
	200 [1]		35.9	35.4	42.9	63.9
	250		40.8	39.8	49.3	74.8

1) In accordance with company standard

6.3 FFR FITTINGS

Double flange transition pieces

According to EN 545 and company standard



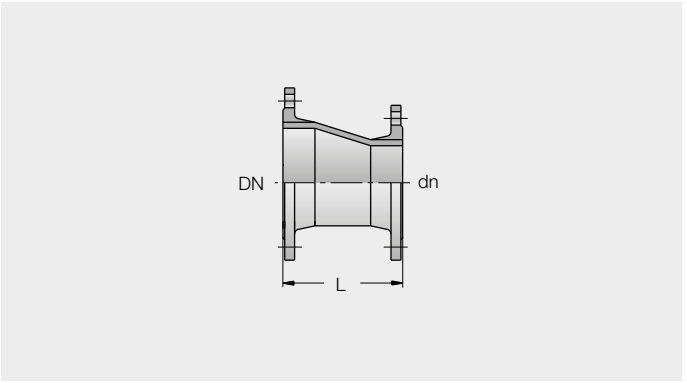
DN1	dn	Dimensions [mm] L	Weight ~ [kg] PN10	PN16	PN25	PN40
350	200 [1]	600	87.0	90.0	103.0	127.0
	250 [1]	300	44.4	46.9	59.4	90.4
	300		49.7	52.2	66.2	103.2
400	200 [1]	300	45.6	50.5	63.5	98.0
	250 [1]		49.1	54.6	69.6	113.1
	300		54.4	59.4	76.4	125.9
	350		58.1	66.6	86.1	141.1
500	350 [1]	600	145.0	149.0	166.0	201.0
	400		133.6	163.6	175.6	210.6
600	400 [1]	600	178.0	219.0	237.5	309.5
	500		185.5	226.5	257.0	343.0
700	400 [1]	600	253.5	281.5	334.5	–
	500 [1]		258.0	273.0	337.0	
	600		301.4	332.4	285.4	
800	500 [1]	600	308.5	359.5	442.5	–
	600 [1]		363.0	375.0	459.0	
	700		397.3	431.3	484.3	
900	600 [1]	600	336.0	384.0	453.0	–
	700 [1]		456.0	497.0	481.0	
	800		374.2	414.2	518.2	
1000	800 [1]	600	516.0	612.0	739.0	–
	900		530.2	592.2	576.2	

1) In accordance with company standard

6.3 FFRE FITTINGS

Eccentric double flange transition pieces

In accordance with company standard

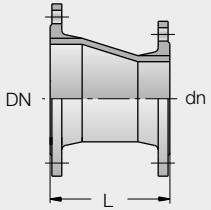


DN1	dn	Dimensions [mm] L	Weight ~ [kg] PN10	PN16	PN25	PN40
50	40	200	7.0	7.0	7.0	7.0
65	40	200	8.5	8.5	8.5	8.5
	50		9.0	9.0	9.0	9.0
80	40	200	9.2	9.2	9.2	9.2
	50		9.7	9.7	9.7	9.7
	65		10.7	10.7	10.7	10.7
100	40	200	11.1	11.1	11.6	11.6
	50		12.1	12.1	12.1	12.1
	65		12.6	12.6	12.6	12.6
	80		13.1	13.1	13.1	13.1
125	50	200	13.6	13.6	14.2	16.1
	65		14.6	14.6	15.1	16.4
	80		15.6	15.6	16.2	17.5
	100	300	16.5	16.5	17.1	18.4
150	50	300	17.9	17.9	21.5	23.5
	80		19.0	19.0	23.0	25.0
	100		20.0	20.0	24.5	26.5
	125		25.5	25.5	25.5	29.0
200	80	300	24.4	25.0	27.0	33.5
	100		24.5	24.5	28.0	34.0
	125		25.5	25.5	29.0	35.0
	150		29.5	29.5	31.5	38.5

6.3 FFRE FITTINGS

Eccentric double flange transition pieces

In accordance with company standard

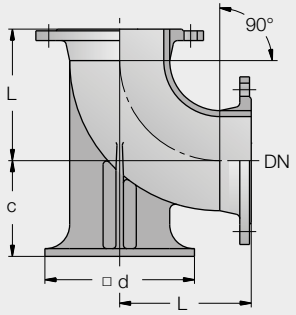


DN1	dn	Dimensions [mm] L	Weight ~ [kg] PN10	PN16	PN25	PN40
250	100	300	35.5	35.5	39.0	49.0
	125		36.0	36.0	39.5	50.5
	150		40.0	40.0	42.5	51.5
	200		42.0	42.0	48.0	64.0
300	100	300	40.5	40.5	45.0	60.0
	150		42.5	46.1	59.0	82.0
	200		53.1	53.1	63.0	87.5
	250		55.0	55.0	66.5	94.0
350	200	500	82.0	85.0	99.0	122.0
	250		83.0	85.5	101.0	128.0
	300		108.0	114.0	125.0	162.0
400	150	500	81.0	90.0	102.0	138.0
	200	600	85.0	85.0	110.5	150.5
	250	500	91.0	102.0	123.0	163.0
	300		105.0	104.0	124.0	183.0
	350		117.0	126.0	145.0	200.0
500	250	500	114.5	127.0	140.5	186.0
	300		115.0	135.0	153.0	204.0
	350		120.5	141.0	158.0	207.0
	400		162.0	162.0	194.0	194.0
600	300	500	182.0	193.0	212.0	288.0
	400		196.0	241.0	252.0	345.0
	500		236.0	252.0	262.0	357.0

6.3 N FITTINGS

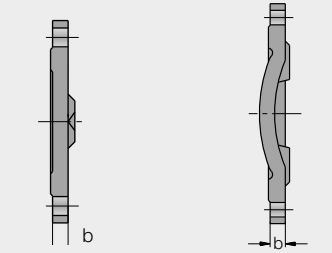
90° double flange foot bends

According to EN 545



DN	Dimensions [mm] L	c	□ d	Weight ~ [kg] PN 10	PN 16	PN 25	PN 40
80	165	110	180	13.2	13.2	13.2	13.2
100	180	125	200	16.9	16.9	17.9	17.9
125	200	140	225	22.1	22.1	23.1	26.1
150	220	160	250	28.8	28.8	30.8	35.8
200	260	190	300	46.2	45.2	49.7	60.2
250	350	225	350	73.5	72.5	80.5	101.0
300	400	255	400	103.9	102.9	113.9	144.9
350	450	290	450	136.0	142.0	158.0	201.0
400	500	320	500	176.4	186.4	209.4	277.4
500	600	385	600	281.0	311.0	335.0	402.0
600	700	450	700	425.0	478.0	506.0	612.0

6.3 X FITTINGS
Blanking flanges
According to EN 545



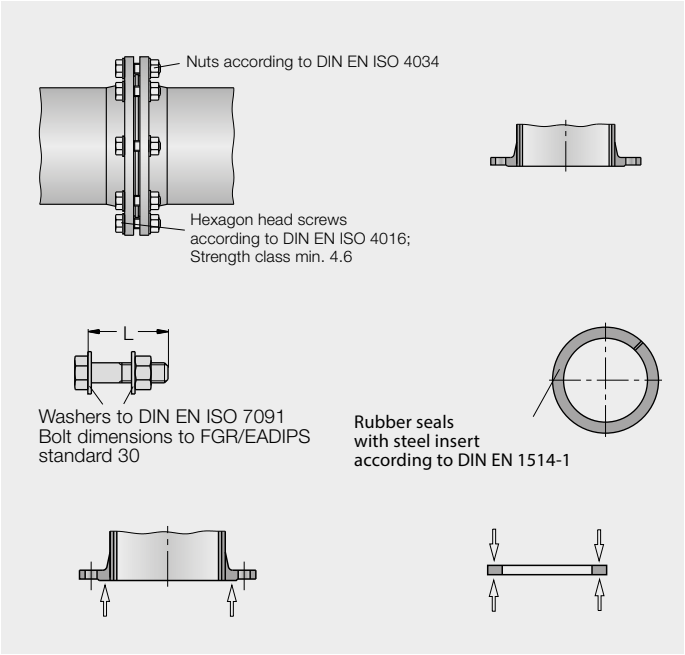
Up to DN 250 Over DN 250

DN	b [mm] PN 10	PN 16	PN 25	PN 40	Weight ~ [kg] PN 10	PN 16	PN 25	PN 40	Options for boring [“]
40	16.0	16.0	16.0	16.0	2.5	2.5	2.5	2.5	1 × ½", centred
50	16.0	16.0	16.0	16.0	3.0	3.0	3.0	3.0	
65	16.0	16.0	16.0	16.0	4.0	4.0	4.0	4.0	
80	16.0	16.0	16.0	16.0	3.6	3.6	3.6	3.6	1 × 2", centred
100	16.0	16.0	16.0	16.0	4.3	4.3	4.8	4.8	
125	16.0	16.0	16.0	20.5	5.6	5.6	6.2	7.9	
150	16.0	16.0	17.0	23.0	7.2	7.2	8.3	11.1	
200	17.0	17.0	19.0	27.0	11.0	10.8	13.3	20.0	
250	19.0	19.0	21.5	31.0	16.9	16.6	21.0	33.5	
300	20.5	20.5	23.5	35.5	26.0	25.5	32.0	51.5	2 × 2", eccentric
350	20.5	22.5	26.0	40.0 [1)]	33.0	37.0	46.0	73.5	
400	20.5	24.0	28.0	44.0 [1)]	41.0	49.0	62.5	106.0	
500	22.5	27.5	32.5	48.0 [1)]	65.0	85.5	102.0	151.0	
600	25.0	31.0	37.0	53.0 [1)]	99.5	136.0	159.0	230.0	
700	27.5	34.5	41.5 [1)]	–	147.0	179.0	225.0	–	
800	30.0	38.0	46.0 [1)]	–	207.0	252.0	325.0	–	
900	32.5	41.5	50.5 [1)]	–	273.0	335.0	429.0	–	
1000	35.0	45.0	55.0 [1)]	–	360.0	453.0	578.0	–	

1) In accordance with company standard, flange joint dimensions according to EN 1092-2; higher pressures on request

6.3 DN 80 TRANSITION FLANGES
Transition flanges from PN 10 to PN 40
In accordance with company standard

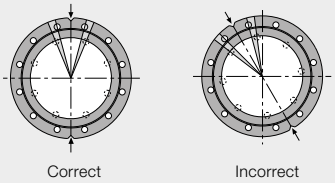
DN	Dimensions [mm] D	e	PN [bar]	Weight ~ [kg]
80	200	27	10/40	3.9



Scope of application
These installation instructions apply to pipes and fittings made of ductile cast iron according to EN 545 with flanges according to EN 1092-2. The surfaces marked with an arrow on the sealing strip, seal and screw holes must be cleaned, and any accumulations of paint must be removed.

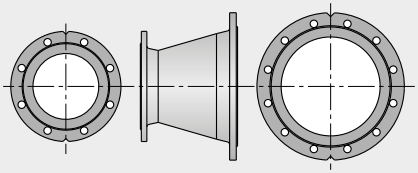
Assembly of the joint
For recommendations on transport, storage and installation, see Chapter 9. For reasons of better fitting and operating safety, only flat seals with a steel insert should be installed.

Flanged pipes and fittings must be carefully supported.
Different loads and settlements cannot be absorbed by the rigid pipe joints. Under no circumstances should the pipes and fittings be supported with stones and other materials.



Arrangement of the screw holes
When arranging the screw holes with flanged pipes and flange fittings, the rule is that there are no screw holes in the flange axis perpendicular to the pipeline level.

Note for the installation of flange fittings
To facilitate proper fitting, there are two notches opposite each other on the flanges of the fittings. These must be aligned vertically or horizontally during installation.



Installation of FFR fittings
Example: FFR 300/200 PN 10

Due to the different number of screw holes on FFR fittings, the installed valves and fittings will be in a slanted position if installed incorrectly. Possible degree of rotation (depending on the nominal size) up to 22.5°.

Note: The degree of rotation for large nominal sizes is hardly noticeable.

Tightening torques
The tightening torque (MD) depends on the sealing material, the nominal size (DN) and the nominal pressure (PN).

Please contact your seal manufacturer.

Formulae

L_H = H/tan α
L_S = H/sin α
L_{FF} = LS - 2 • L
L_{Ges} = LH + 2 • L

H = height offset – pipe axis to pipe axis
L = leg length of the FFK
α = angle of the FFK

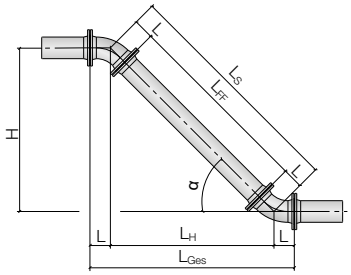


Table 1: Leg lengths "L" [cm] of the FFK fittings depending on angle α and diameter "DN"

Angle α of the FFK	Leg length L [cm] of the FFK								
	DN 80	DN 100	DN 125	DN 150	DN 200	DN 250	DN 300	DN 350	DN 400
11°	13.0	14.0	15.0	16.0	18.0	21.0	25.0	10.5	11.3
22°	13.0	14.0	15.0	16.0	18.0	21.0	25.0	14.0	15.3
30°	13.0	14.0	15.0	16.0	18.0	21.0	25.0	16.5	18.3
45°	13.0	14.0	15.0	16.0	18.0	35.0	40.0	29.8	32.4
90°	16.5	18.0	20.0	22.0	26.0	35.0	40.0	45.0	50.0

Angle α of the FFK	Leg length L [cm] of the FFK					
	DN 500	DN 600	DN 700	DN 800	DN 900	DN 1000
11°	13.5	17.4	19.4	21.3	–	–
22°	18.5	25.4	28.4	31.4	–	–
30°	22.0	30.9	34.6	38.3	–	–
45°	37.5	42.6	47.8	52.9	58.1	63.2
90°	60.0	70.0	80.0	90.0	100.0	110.0

Deviations in dimensions are possible. Leg lengths "L" can also be found in Chapter 6.

6.5 Calculation of height offsets
with flange fittings

Table 2: To determine the length "L_S" [cm] depending on angle α and height offset "H"

Angle α of the FFK	sin α	Length of slant "L_S" [cm] Height offset H [cm] (pipe axis to pipe axis)									
		5	10	15	20	25	30	35	40	45	50
11°	0.19081	26.2	52.4	78.6	104.8	131.0	157.2	183.4	209.6	235.8	262.0
22°	0.37461	13.3	26.7	40.0	53.4	66.7	80.1	93.4	106.8	120.1	133.5
30°	0.5	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0
45°	0.70711	7.1	14.1	21.2	28.3	35.4	42.4	49.5	56.6	63.6	70.7
90°	1	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0

Angle α of the FFK	sin α	Length of slant "L_S" [cm] Height offset H [cm] (pipe axis to pipe axis)									
		55	60	65	70	75	80	85	90	95	100
11°	0.19081	288.2	314.4	340.7	366.9	393.1	419.3	445.5	471.7	497.9	524.1
22°	0.37461	146.8	160.2	173.5	186.9	200.2	213.6	226.9	240.2	253.6	266.9
30°	0.5	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0	190.0	200.0
45°	0.70711	77.8	84.9	91.9	99.0	106.1	113.1	120.2	127.3	134.3	141.4
90°	1	55.0	60.0	65.0	70.0	75.0	80.0	85.0	90.0	95.0	100.0

Table 3: To determine the length "L_H" [cm] depending on angle α and height offset "H"

Angle α of the FFK	tan α	Horizontal length of offset "L_H" [cm] from inflexion point to inflexion point Height offset H [cm] (pipe axis to pipe axis)									
		5	10	15	20	25	30	35	40	45	50
11°	0.19438	25.7	51.4	77.2	102.9	128.6	154.3	180.1	205.8	231.5	257.2
22°	0.40403	12.4	24.8	37.1	49.5	61.9	74.3	86.6	99.0	111.4	123.8
30°	0.57735	8.7	17.3	26.0	34.6	43.3	52.0	60.6	69.3	77.9	86.6
45°	1	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0
90°	∞	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Angle α of the FFK	tan α	Horizontal length of offset "L_H" [cm] from inflexion point to inflexion point Height offset H [cm] (pipe axis to pipe axis)									
		55	60	65	70	75	80	85	90	95	100
11°	0.19438	283.0	308.7	334.4	360.1	385.8	411.6	437.3	463.0	488.7	514.5
22°	0.40403	136.1	148.5	160.9	173.3	185.6	198.0	210.4	222.8	235.1	247.5
30°	0.57735	95.3	103.9	112.6	121.2	129.9	138.6	147.2	155.9	164.5	173.2
45°	1	55.0	60.0	65.0	70.0	75.0	80.0	85.0	90.0	95.0	100.0
90°	∞	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

6.5 Calculation of height offsets with flange fittings

How long must the FF fitting be if the FFK fitting is present and the height offset is known?

1. Take the value "L_S" depending on the known height offset and the angle α of the FFK fitting from Table 2.
2. Refer to Table 1 or our drinking water catalogue for leg length "L" of the FFK fitting.
3. To determine the required length of the FF fitting "L_{FF}", subtract two times "L" from "L_S".

Example:
FFK 30°, DN 200, H = 70 cm

140 cm

18.0 cm

$L_{FF} = 140\,cm - 2 \bullet 18\,cm = 104\,cm$

How large is the height offset "H" if the FF fitting and the FFK fittings are present?

1. Measure the length of the FF fitting "L_{FF}".
2. Refer to Table 1 or our drinking water catalogue for leg length "L" of the FFK fitting.
3. Calculate "L_S": $L_S = L_{FF} + 2 \bullet L$
4. Sin α of the existing FFK fittings can be found in Table 2.
5. The resulting height offset "H" is calculated as follows: $H = L_S \bullet \sin \alpha$

Example:
FFK 30°, DN 200, LFF = 104 cm

104 cm
18.0 cm

$L_S = 104\,cm + 2 \bullet 18\,cm = 140\,cm$
0.5 cm

$H = 140\,cm \bullet 0.5 = 70\,cm$

How long is the offset "L_{TOT}" if the height offset "H" and the angle of the FFK fittings are known?

6. Take the value "LH" depending on the known height offset and the angle of the FFK fitting from Table 3.
7. Refer to Table 1 or our drinking water catalogue for leg length "L" of the FFK fitting.
8. Calculate "LTOT": LTOT = LH + 2 • L

Example:
FFK 30°, DN 200, H = 70 cm

121.2 cm

18.0 cm

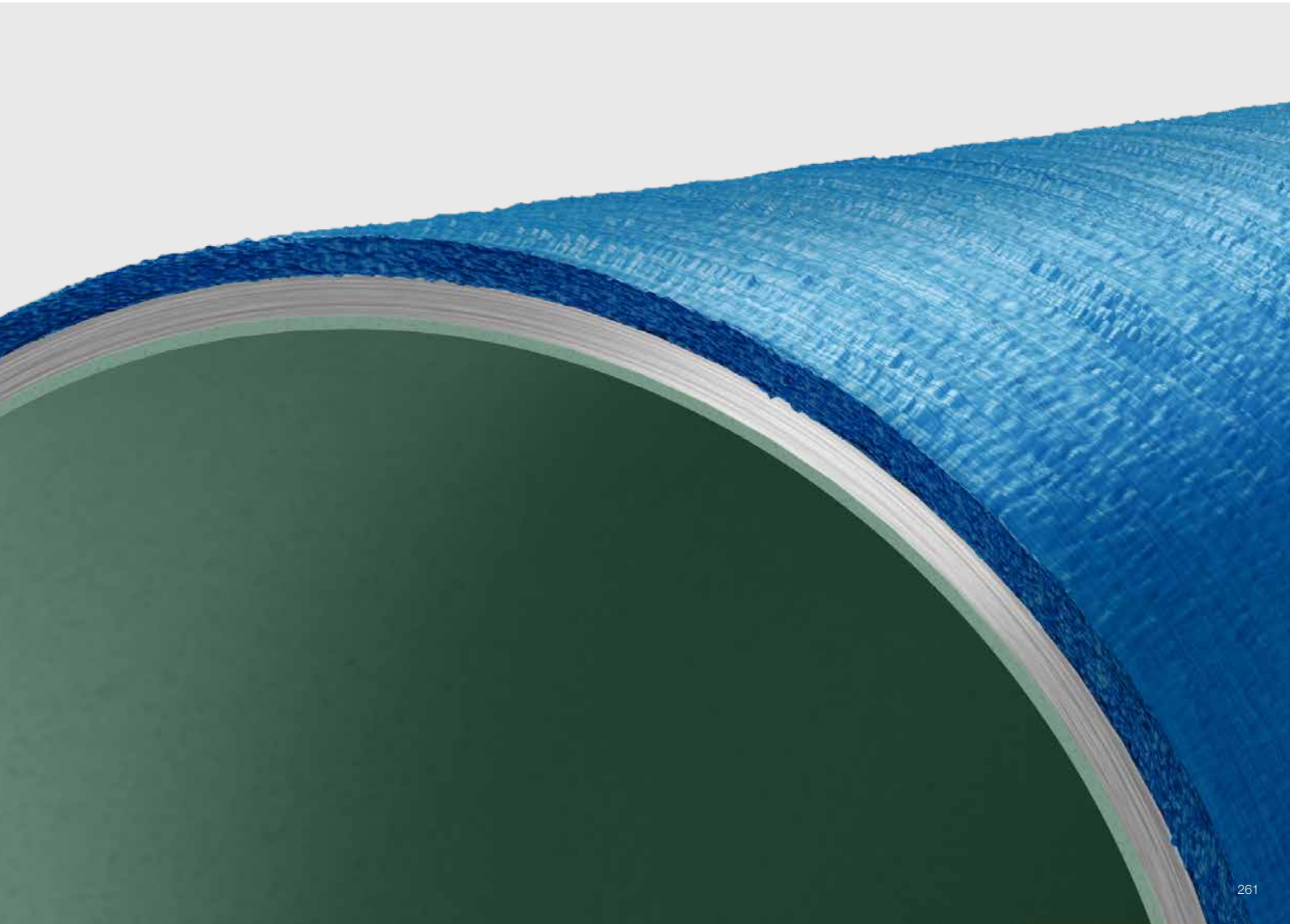
$L_{TOT} = 121.2\,cm + 2 \bullet 18\,cm = 157.2\,cm$

VOLL N HYDRO

7

COATINGS

Layout, how it works, areas of application and installation instructions



7.1 Introduction
Cement mortar external coating
(DUKTUS ZMU / Swiss FZM / CEMPUR*)

Ductile cast-iron pipes and fittings are supplied with internal and external coatings applied at the plant. The various coatings for pipes can be selected depending on the most varied factors, and can be combined in almost any way. Some decisive influencing factors are:

- Flow medium
- Ground and groundwater aggressiveness
- Grain size of embedding
- Temperature of the medium
- Temperature of the environment
- Installation procedure

The following chapter describes the layout, mode of operation and installation conditions of the various internal and external coatings for pipes. As a coating for fittings, the epoxy resin coating in accordance with EN 14 901 has caught on as a state-of-the-art solution both internally and externally. Fittings with this coating can be used for drinking water supply as well as for wastewater disposal. Other coatings, such as a cement mortar lining or enamel, are available on request.

***DUKTUS ZMU / cement mortar coating/Swiss fibre-reinforced cement mortar/CEMPUR**

7.1 External coating
Cement mortar coating
(DUKTUS ZMU / Swiss FZM / CEMPUR*)

Layout
The cement mortar coating is available for pipes of nominal sizes DN 80 to DN 1000 in installation lengths of 6 m and 5 m and for all push-in socket joints. It complies with EN 15 542. The nominal layer thickness is accordingly 5 mm. There is always a zinc coating (see Chapter 7.4) of at least 200 g/m^2 under the cement mortar coating. Priming can additionally be applied between the zinc and cement mortar coating. However, this can be omitted with a polymer-modified cement mortar coating. The cement mortar is applied using an extrusion (winding) process or a spraying process, depending on the nominal size.

The socket is protected with a rubber protective sleeve or with shrink material. (See page 264) For special operating conditions, such as trenchless installation in loose soils, we also offer our 'Plus' cement mortar coating. For this, the pipe is coated with a cement mortar coating until a cylindrical outer contour is created.

***DUKTUS ZMU / cement mortar coating/Swiss fibre-reinforced cement mortar/CEMPUR**

7.1 External coating
Cement mortar coating
(DUKTUS ZMU / Swiss FZM / CEMPUR*)

How it works
The ZMU offers highly effective corrosion protection and protects against both chemical and mechanical attacks.
The chemical protective effect is primarily based on the porosity and alkalinity of the mortar used based on blast furnace cement. Due to the influence of moisture in the ground or groundwater, a pH value > 10 is permanently generated on the surface of the cast-iron pipe, which reliably prevents corrosion. The zinc coating under the ZMU maintains corrosion protection, even in the unusual case of mechanical damage to the ZMU.

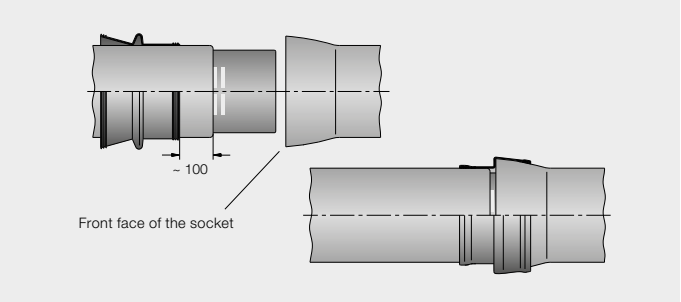
In addition, permissible mechanical loads are specified by the corresponding specifications of EN 15 542. For example, the adhesive pull strength and impact resistance are standardised. The result of this is that the cement mortar coating has an outstanding mechanical load capacity.

Applications
Due to the excellent mechanical and chemical protective properties of the ZMU, pipes with this outside coating can be used virtually anywhere. Essential applications are:

– Aggressive/contaminated soils
  In accordance with Annex D to EN 545, ductile cast-iron pipes with a fibre-reinforced cement mortar coating in accordance with EN 15 542 can be installed in ground of any corrosiveness.
– Coarse-grained pipe coating material
  In turn, DVGW worksheet W 400-2 regulates the permissible grain sizes of pipe coating materials. According to Annex G of this worksheet, a maximum grain size of 100 mm in a round or broken form is permissible for pipes with a cement mortar coating.
– Trenchless installation procedure
  The trenchless installation procedures relevant for ductile cast-iron pipes are regulated in DVGW worksheets GW 320-1 to GW 324. Accordingly, pipes with a cement mortar coating are approved and suitable for all these procedures.
– Stray current
  According to the latest investigations, cast-iron pipes with a cement mortar coating should be used in areas with stray currents. When installing connections that are not electrically conductive, a negative impact on the pipework due to stray currents can therefore be ruled out.

***DUKTUS ZMU / cement mortar coating/Swiss fibre-reinforced cement mortar/CEMPUR**

7.1 External coating
Cement mortar coating
(DUKTUS ZMU / Swiss FZM / CEMPUR*)



Cement mortar coating installation instructions
These installation instructions apply to pipes made of ductile cast iron in accordance with EN 545, with cement mortar coating (ZMU) in accordance with EN 15 542. The respectively applicable installation instructions must be observed when establishing the pipe joint.

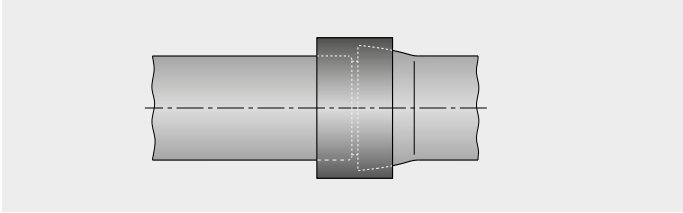
Notes for installation
Installation must be carried out in such a way that the cement mortar coating is not damaged. The following options are available to protect the socket joints:
– Cement mortar protective sleeve,
– shrink material or protective strips (according to EN 30 672),
– mortar bandage (e.g. Ergelit tape) for special applications.

Cement mortar protective sleeves
Cement mortar protective sleeves can be used universally for TYTON, BRS and BLS push-in socket joints up to DN 1000.Before fitting the joint, the sleeve is upended and – with the larger diameter first – pulled onto the spigot end until the cement mortar coating protrudes approx. 100 mm. Fitting can be made easier by using lubricant on the cement mortar coating.

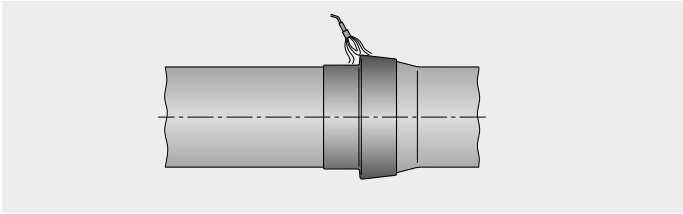
After fitting the joint and checking the seal seat with the button, the sleeve is folded over, pulled up to the front face of the socket and slipped over the socket. It then fits snugly and tightly.

Shrink material and protective strips
Shrink material and protective strips can be used for all joints. The shrink material must be suitable for the dimensions of the respective joint and the application; see page 264.

***DUKTUS ZMU / cement mortar coating/Swiss fibre-reinforced cement mortar/CEMPUR**



Applying the (closed) shrink-on collar
Prepare the surface to be coated in accordance with data sheet GW 15, i.e. remove rust, grease, dirt and all loose particles from the installation area. Preheat the surface with a propane gas flame to approx. 60 °C in order to dry it. The shrink-on collar is then pulled over the joint, and about half of the length should be on the collar.



The protective film in the shrink-on collar may only be removed after positioning on the socket and shortly before heating. Using a propane gas flame set to a gentle heat, the shrink-on collar is heated evenly all round at the level of the front face of the socket, until the shrinking process begins and the socket contour becomes visible. Then, under uniform temperature control, with the aim of guiding the burner so that it is fanning in the circumferential direction, first the socket part is shrunk, and then the part of the pipe shaft starting from the front face of the socket is shrunk.

The process is carried out correctly if:

– The socket/sleeve is completely shrunk onto the pipe joint,
– it fits smoothly, without cold spots and air bubbles, and the sealing adhesive has been pressed out at both ends,
– the required overlap of 50 mm on the plant coating has been adhered to.

*DUKTUS ZMU / cement mortar coating/Swiss fibre-reinforced cement mortar/CEMPUR

Coating of a socket joint with (open) shrink fit sleeve made of tape material
Open shrink fit sleeves are available in a prefabricated form with a closing flap already integrated, or in rolls of 30 m with one closing flap for each socket. The shrink tape, in rolls of 30 metres, must accordingly be cut to size on the construction site. Prepare the surface to be coated in accordance with data sheet GW 15, i.e. remove rust, grease, dirt and all loose particles from the installation area. Preheat the surface with a propane gas flame to approx. 60 °C in order to dry it.

Pull approx. 150 mm of the protective film away from the sleeve. Position the end of the sleeve at right angles to the pipe axis, centred over the pipe joint, and turn the sleeve loosely while simultaneously removing the remaining protective film. The overlap of the sleeve ends should be at least 80 mm, and should be easily accessible in the upper third of the pipe. At low ambient temperatures, it is advantageous to briefly heat the adhesive side of the overlap and the closing flap.

Evenly heat the closing flap, placed so that it is centred over the overlap, from the outside with a gentle yellow flame while subjecting it to constant movement, until the grid structure of the fabric becomes visible. Then press on well with a glove. Shrink the sleeve onto the pipe socket, first on the side facing away from the closing flap and then onto the spigot end in the same way, while moving the flame evenly in the direction of the pipe circumference.

The process is carried out correctly if:

– The socket/sleeve is completely shrunk onto the pipe joint,
– it fits smoothly, without cold spots and air bubbles, and the sealing adhesive has been pressed out at both ends,
– the required overlap of 50 mm on the plant coating has been adhered to.

The deflection capabilities specified in the installation instructions can also be fully utilised after insulation with the socket insulation types described above.

Protective strips can also be used instead of molecularly crosslinked Thermofit shrink materials, if they comply with the requirements according to EN 30 672 and have an EN/DVGW registration number.

*DUKTUS ZMU / cement mortar coating/Swiss fibre-reinforced cement mortar/CEMPUR

7.1 External coating
Cement mortar coating
(DUKTUS ZMU/ Swiss FZM / CEMPUR*)

Wrapping with protective strips
Once the joint has been completed, the protective tape is wrapped over the joint in several layers so that it covers the cement mortar coating ≥ 50 mm.

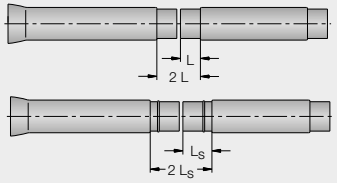
Wrapping with mortar bandage (e.g. Ergelit tape)
Soak the mortar tape in a bucket filled with water until no air bubbles escape. Maximum two minutes.

Remove the wet tape and gently squeeze it out.

Wind the tape onto the area to be coated (cover the cement mortar coating ≥ 50 mm) and adapt it to the contour. For a layer thickness of 6 mm, wrap the bandage twice or overlap it by 50%. After approx. one hour to three hours, the subsequent insulation is mechanically loadable.

Filling the trench
The pipes must be bedded in accordance with EN 805 or DVGW worksheet W 400-2. Virtually any excavated material can be used as filling material, even substrates including stones up to a maximum grain size of 100 mm (see DVGW worksheet W 400-2). A sand coating or coating with foreign material is only necessary in special cases. In the area of public thoroughfares, the data sheet for filling trenches (Forschungsgesellschaft für das Strassen- und Verkehrswesen e. V (German Road and Transportation Research Association) in Cologne) must be observed.

The push-in socket joints protected with cement mortar protective sleeves or shrink material must be coated with fine-grained material or protected with pipe protection mats.



Cutting pipes to length
Ensure that the pipes can be cut (see page 316). Before cutting, the cement mortar coating should be removed from length 2 L or 2 LS according to the table below. (For pushovers, the dimension for "pushing on" must additionally be considered).

***DUKTUS ZMU / cement mortar coating/Swiss fibre-reinforced cement mortar/CEMPUR**

7.1 External coating
Cement mortar coating
(DUKTUS ZMU/ Swiss FZM / CEMPUR*)

DN	TYTON/BRS L (mm)	BLS LS (mm)
80	95	165
100	100	175
125	100	185
150	105	190
200	110	200
250	115	205
300	120	210
350	120	–
400	120	230
500	130	245
600	145	300
700	205	315
800	220	330
900	230	345
1000	245	360

A TYTON spigot end length without a cement mortar coating applies to sockets according to
EN 28 603 up to DN 600 form A
from DN 700 form B (long socket)

Steps for removing the cement mortar coating

- Apply the marking for cement mortar coating cuts according to the table above
- Cut into the cement mortar coating along the marking to about half the layer thickness (2 to 3 mm deep). Cutting discs of type 100 EHT (Caution: Do not cut into the cast-iron wall) or special cutting discs with a depth limitation, for example, are suitable for cutting into the cement mortar coating. Wear suitable work clothing and protective equipment (e.g. goggles, respiratory protection, etc.).
- Make two to three longitudinal cuts (as described above) scattered over the circumference of the area to be detached
- For pipes with bonding agent between the zinc and cement mortar coating, it is necessary to heat the cement mortar coating to approx. 160 to 200 °C before stripping. These pipes are marked with a line under the designation "DIN EN 545"
- Remove the cement mortar coating by hitting gently with a hammer – starting at the longitudinal separating point
- Separating all cuts using a chisel
- Remove the cement mortar coating, and remove any cement mortar coating residues from the spigot end using a scraper and wire brush
- The pipe can now be separated and the spigot end chamfered as described in the "Shortening pipes" section

The resulting galvanised spigot ends must always be repainted with a suitable finishing layer approved for drinking water.

***DUKTUS ZMU / cement mortar coating/Swiss fibre-reinforced cement mortar/CEMPUR**

Installation of valve tapping fittings
The installation of house connections on ductile cast-iron pipes with a cement mortar coating is preferably carried out using valve tapping fittings with an internal sealing sleeve. This type of valve tapping fitting provides direct sealing against the cast-iron pipe surface in the drilled hole inside the perforated pipe. Valves and fittings of this type are offered by numerous manufacturers, such as Erhard, EWE or Hawle.

For further information, see DVGW data sheet W 333.

Repairing the cement mortar coating on the construction site
Any parts of the ZMU which have come off may only be repaired using the repair set provided by the pipe manufacturer.

Contents:
Approx. 4 kg of cement / sand mixture, an additional approx. 5 m of gauze, 200 mm wide, approx. 1 litre of additive mixture. The contents are specifically intended for use with DUKTUS pipes. No component may be replaced by any material, or used for cement types other than those specified on the repair set.

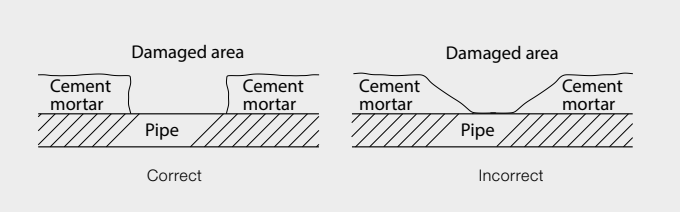
Repair instructions:
Professional repair is only possible at temperatures above 5 °C. Apart from the repair set, you will need:

Rubber gloves
Dust-proof protective goggles
Wire brush
Spatula
Additional mixing vessel
Possibly some water

In the event of substantial damage: Hammer; chisel

***DUKTUS ZMU / cement mortar coating/Swiss fibre-reinforced cement mortar/CEMPUR**

7.1 External coating
Cement mortar coating
(DUKTUS ZMU / Swiss FZM / CEMPUR*)



Preparation of the repair site
In the case of slight surface damage, only remove the loose and not the tightly adhering components in the area of the site of damage with the wire brush. Finally, moisten the site of damage. In the event of more major damage, it is advisable to completely remove the cement mortar from the site of damage with a hammer and chisel (down to the bare metal). Protective goggles must be worn here. The cement mortar must be removed in such a way that straight edges are created:

When removing the cement mortar, excessive use of force must be avoided in order to prevent it from being taken off in the area next to the site of damage.

Mixture
Stir the additive solution well at the beginning. The mortar should be prepared by adding as little additive and water as possible until a mixture suitable for application with a spatula is produced – the diluted additive normally contains enough water. Initially, only use the additive solution and dose carefully. If necessary (e.g. at high temperatures in summer), top up with water.

Processing
As soon as the mortar is easy to work with, it is used to fill the site of damage, and then the repaired area is smoothed with a wide, damp paintbrush or a damp hand brush, especially the edge zones of the repaired surface. For large areas of damage, the gauze is used to support the mortar in the repair area. To do this, the gauze is placed approximately 1 to 2 mm below the surface of the mortar. The gauze must not come into contact with the metal surface in order to avoid wicking. Finally, seal the repair set again so that it is airtight.

Drying and commissioning
Particularly large-scale repairs should be covered with film to minimise the risk of crack formation by slow drying. It is recommended to wait at least twelve hours before installation or to protect the repair area sufficiently from mechanical stress.

***DUKTUS ZMU / cement mortar coating/Swiss fibre-reinforced cement mortar/CEMPUR**

7.2 Introduction
External coatings
POLYURETHANE coating
(ECOPUR, ECOCEM)

Polyurethane coatings (PUR)

The PUR coating was created by VONROLL HYDRO in 1972 and has undergone continuous further development ever since. Polyurethane not only protects ductile cast-iron pipes against corrosion, but also ensures that drinking water is hygienic. The PUR external coating can be used in all types of soil. The test report from the renowned Institute of Hygiene in Gelsenkirchen confirms that the PUR coating complies with the German Environmental Protection Agency's "Guideline for Hygienic Assessment of Organic Coatings in Contact with Drinking Water". The tried-and-tested PUR coating process guarantees pore-free coatings and optimum adherence to ductile cast iron. The smooth, glossy surface of the polyurethane and the larger internal diameter in comparison with other pipe linings increase the pipe's hydraulic capacity. Polyurethane is used for both the internal and external coatings. The elasticity of polyurethane means that the coating remains intact even if the pipe deforms.

The PUR coating adheres exceptionally well to the cast-iron surface.

Properties

Polyurethane is made from a bi-component resin. The three-dimensionally linked molecular structure increases the material's mechanical strength. Polyurethane is a solvent-free duroplastic material. It meets the EN 545, ISO 2531 and EN 598 standards.

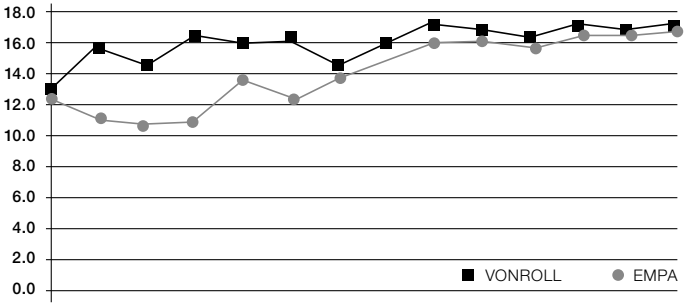
External coating	PUR DN 80 to DN 700 = 0.9 mm
Colour	Outside: Black
Density	1.4–1.5 kg/dm^3
Continuity	Pore-free coating
Adhesive strength	At least > 14 MPa
Dielectric resistance	> 10^8 Ωm^2
Temperature	
Water	*40 °C (continuous); up to 80 °C (short-term)*
Air	*120 °C*
Impact resistance	*min. 40 Nm at 20 °C*
Salt spray effect	*after 1000 hours; no effect*
Elongation	*> 10%*
Friction coefficient	*c < 0.01 mm*
Chemical resistance	– Acid/base: pH value of 1 to 14 – Inorganic solvents – Sulphuric acid (wastewater) – *Industrial wastewater*
Thermal expansion	*20 × 10-6 1/K*
Deposits:	*None*

Mechanical properties	Symbol	Unit	Pipes	Fittings
Minimum tensile strength	Rm	MPa	420	420
Yield strength	Rp 0.2	MPa	270	270
Min. elongation at fracture	A	%	10	5
Minimum crush resistance		MPa	550	550
Bursting strength		MPa	300	300
Longitudinal flexural strength		MPa	420	420
Density	I	kg/dm^3	7.05	7.05
Elastic modulus	E	MPa	1.7 x 10^5	1.7 x 10^5
Thermal expansion coefficient	a	1/K	10 x 10^{-6}	10 x 10^{-6}
Hardness		HB	< 230	< 250

7.2 External coatings
POLYURETHANE coating
(ECOPUR, ECOCEM)

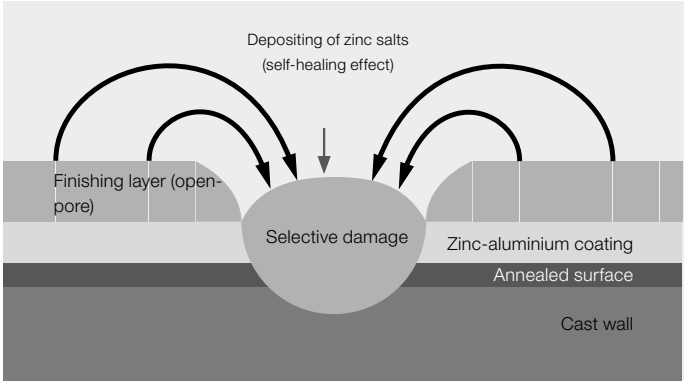
Benefits for the user
The exceptional combination of ductile cast iron and polyurethane (PUR) materials, as well as the proven push-in socket connection technique, possess outstanding properties and offer users the following benefits.

– Long service life
– Cost-effective pipe laying
– Complete corrosion protection
– High mechanical strength
– Ground movement compensation
– Easy to cut to length and bore
– Reduced maintenance costs



Adhesive strength of PUR coating – VONROLL vs. EMPA (target value)

7.3 Introduction
External coatings
Zinc-aluminium coating with finishing layer
(DUKTUS ZIPOX+ and DUCPUR)



Cathodic protective effect of zinc on damage to the protective layer

Layout
The zinc-aluminium coating with finishing layer is available for pipes of nominal sizes from DN 80 to DN 1000 (ZIPOX+) and DN 80 to DN 700 (DUCPUR) in an installation length of 6 m and for all push-in socket joints. The finishing layer consists of a blue epoxy resin coating. It complies with EN 545. Other colours on request. The average layer thickness of the finishing layer is 70 µm. There is a zinc-aluminium alloy (85% zinc and 15% aluminium) of at least 400 g/m^2 under the finishing layer.

How it works
The protective effect of the zinc-aluminium alloy with finishing layer is based on three factors:
– The electrochemical effect of the zinc
– A reduction in the post-diffusion of the attacking medium due to the water-insoluble zinc reaction products formed
– The antibacterial effect of zinc salts

If the corrosion protection is damaged down to the cast-iron surface, an electrochemical element, known as a macro-element, forms at the site of damage. According to the galvanic series of metals, zinc is less noble than iron, it has a more negative electrochemical potential, and it dissolves in the event of a conductive connection with iron and in the presence of an electrolyte. In electrochemical terms, the exposed cast-iron surface therefore acts as the cathode and the zinc-covered surface of the pipe acts as the anode. Zinc ions migrate to the site of damage and form a scarring layer that prevents the risk of corrosion.

7.3 External coatings
Zinc-aluminium coating with finishing layer
(DUKTUS ZIPOX^{+} and DUCPUR)

In the case of underground pipes, the zinc layer is converted over time into a dense, tightly adhering, impermeable and uniformly crystalline layer of insoluble compounds, consisting of zinc oxides, hydrates and zinc salts of varying composition. Although the exchange processes between zinc and soil are hindered by the porous finishing layer, they are not completely suppressed, and conditions are created for a slow conversion in a spatially limited area that are favourable for crystallisation of salts. It is due to this layer of zinc corrosion products that the protective effect is retained, even if the originally present metallic zinc has been converted.

In order to delay the effect of this transformation as long as possible and thus maintain the galvanic protective effect, 15% aluminium is added to the zinc by alloying. This, together with increasing the total weight of zinc, further increases the expected technical service life and extends the applications. In anaerobic substrates, where bacterial corrosion can occur due to sulphate-reducing bacteria, zinc provides additional protection through its antibacterial effect and the ability to increase the pH value at the cast iron/substrate phase boundary.

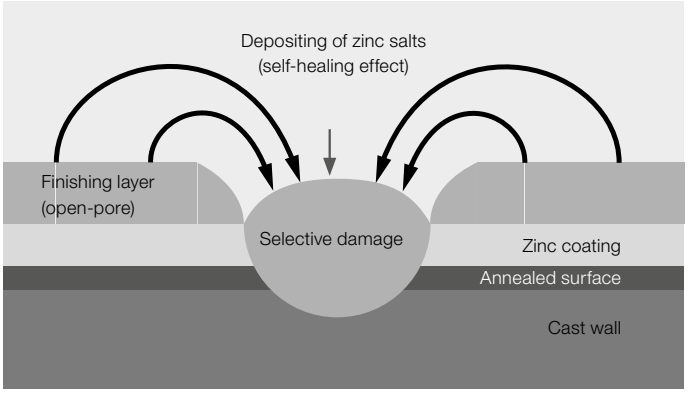
Applications
Pipes with a zinc-aluminium coating are mainly used in areas where substrate replacement is planned. This is mainly due to the permissible grain sizes. The permissible grain of the pipe coating material is limited to 0 to 32 mm (round grain) or 0 to 16 mm (broken material) in accordance with DVGW W 400-2, Annex G.

There are few limits to the aggressiveness of the coating material. According to EN 545, only the following substrates are excluded:
- Acidic, peaty substrates
- Substrates containing waste, ash or slag or that are contaminated by waste or industrial wastewater
- Substrates below sea level with a ground resistance of less than 500 Ohm × cm.

In such substrates, but also when stray currents occur, it is recommended to use pipes with a reinforced coating in accordance with EN standard 545:2010. (Cement mortar coating, CEMPUR, ECOPUR, ECOCEM).

Installation instructions
The instructions in Chapter 9.2 regarding embedding material and shortening of pipes must be observed.

7.4 Introduction
External coatings
Zinc with finishing layer
(DUKTUS ZIPOX)



Cathodic protective effect of zinc on damage to the protective layer

Layout
A zinc coating with a finishing layer is available for pipes of nominal sizes from DN 80 to DN 1000 in installation lengths of 6 m and 5 m, as well as for all push-in socket joints. The finishing layer consists of an epoxy resin coating. It complies with EN 545. The following colours are available:
Blue for drinking water/green for service water, other colours on request.

The average layer thickness of the finishing layer is 70 µm. There is a zinc coating of at least 200 g/m^2 under the finishing layer.

How it works
The protective effect of the zinc coating with finishing layer is based on three factors:
- The electrochemical effect of the zinc
- A reduction in the post-diffusion of the attacking medium due to the water-insoluble zinc reaction products formed
- The antibacterial effect of zinc salts

If the corrosion protection is damaged down to the cast-iron surface, an electrochemical element, known as a macro-element, forms at the site of damage. According to the galvanic series of metals, zinc is less noble than iron, it has a more negative electrochemical potential, and it dissolves in the event of a conductive connection with iron and in the presence of an electrolyte. In electrochemical terms, the exposed cast-iron surface therefore acts as the cathode and the zinc-covered surface of the pipe acts as the anode. Zinc ions migrate to the site of damage and form a scarring layer that prevents the risk of corrosion.

7.4 External coatings
Zinc with finishing layer
(DUKTUS ZIPOX)

In the case of underground pipes, the zinc layer is converted over time into a dense, tightly adhering, impermeable and uniformly crystalline layer of insoluble compounds, consisting of zinc oxides, hydrates and zinc salts of varying composition. Although the exchange processes between zinc and soil are hindered by the porous finishing layer, they are not completely suppressed, and conditions are created for a slow conversion in a spatially limited area that are favourable for crystallisation of salts.

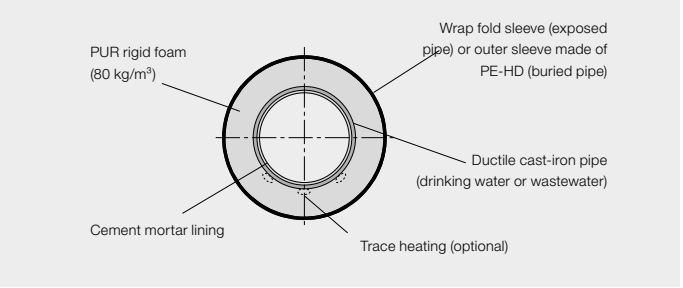
It is due to this layer of zinc corrosion products that the protective effect is retained, even if the originally present metallic zinc has been converted. In anaerobic substrates, where bacterial corrosion can occur due to sulphate-reducing bacteria, zinc provides protection through its antibacterial effect and the ability to increase the pH value at the cast iron/substrate phase boundary.

Applications
Pipes with a zinc coating are mainly used in areas where substrate replacement is planned. This is mainly based on two factors:
– The permissible grain of the pipe coating material is limited to 0 to 32 mm (round grain) or 0 to 16 mm (broken material) in accordance with DVGW W 400-2, Annex G.

According to EN 545, many substrates are approved as coating material – with the exception, however, of substrates
– with a low ground resistance of less than 1500 Ohm × cm when installed above the water level, or less than 2500 Ohm × cm when installed below the water level
– Mixed soils, i.e. with two or more different types of substrates
– Substrates with a pH value below 6 and a high base capacity
– Substrates containing waste, ash or slag or that are contaminated by waste or industrial wastewater.

A thicker finishing layer, with a localised minimum thickness of 100 µm, can extend the area of application to a resistance of 1000 Ohm × cm when installed above the groundwater level and 1500 Ohm × cm below the groundwater level.

7.5 Introduction
External coatings
Thermal insulated cast-iron pipes and fittings
(DUKTUS WKG)



Layout of the WKG pipe system and how it works
The WKG pipe system consists of pipes and elbow sockets (MMK, MMQ) made of ductile cast iron in accordance with EN 545 (water) or EN 598 (wastewater) BLS push-in socket joint. The pipes and fittings are encased in thermal insulation made from CFC-free rigid polyurethane (PUR) foam with an average total bulk density of 80 kg/m³. This rigid foam is protected against external influences in exposed pipes by a wrap fold sleeve made of galvanised sheet steel or stainless steel in accordance with EN 1506, or by a PE-HD outer sleeve in accordance with EN 253 in the case of frost-sensitive buried pipes. In the area of the push-in socket joint, the existing gap is filled with a ring made of soft polyethylene (SPE) and covered with a sheet sleeve corresponding to the selected wrap fold material (exposed pipe system) or a PE shrink bandage for buried pipes (buried pipe system). The insulation slows down the heat loss from the pipe and consequently from the drinking water. This means that even longer periods of stagnation, especially with smaller diameters, can be got through without the pipe freezing. The exact time periods depend on various factors such as ambient temperature, water temperature, insulation layer thickness and local conditions. It is possible to integrate trace heating. This essentially consists of a self-limiting heating cable bonded to the media pipe, which switches on at the desired temperature via a thermostat.

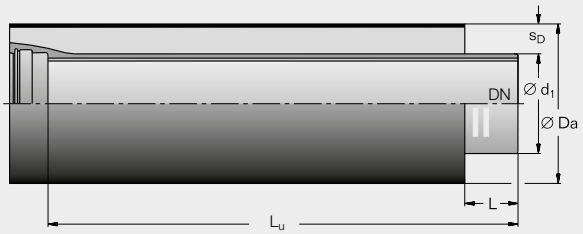
WKG pipes and fittings are used where the pipe is likely to freeze. Typical applications are:

– Bridge pipelines and pipes laid aboveground. Positive locking joint systems (BLS) should always be relied on here. Galvanised sheet steel or stainless steel can be used as a casing.
– Buried pipes with little overlap. In this case, a PE external jacket is relied on. The grain size of the coating material should not exceed 0 to 40 mm (round grain) or 0 to 11 mm (broken material). The corrosiveness of the coating material is not limited. TYTON, BRS or BLS joints are available depending on the circumstances.

7.6 PRODUCT RANGE

WKG pipes with TYTON push-in socket joint

according to EN 28 603, or longitudinal positive locking BRS push-in socket joint* up to DN 600/wrap fold sleeve for exposed pipes/PE-HD outer sleeve for buried pipes

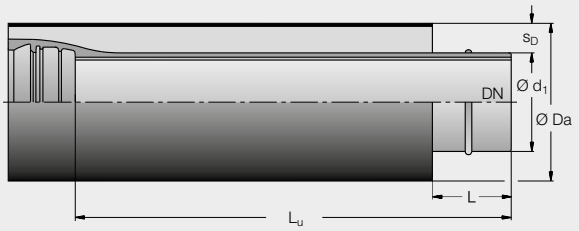


DN	Dimensions [mm]				Weight ~ [kg] 1)	
	Ø Da	Ø d1	L	sD	Exposed pipe*	Buried pipe
80	180	98	94	41.0	112	108
100	200	118	98	41.0	135	129
125	225	144	101	40.5	168	159
150	250	170	104	40.0	207	195
200	315	222	110	46.5	276	261
250	400	274	115	63.0	369	366
300	450	326	120	62.0	453	456
400	560	429	120	65.5	683	696
500	710	532	130	89.0	966	983
600	800	635	130	82.5	1218	1266
700	900	738	172	81.0	1548	1614
800	1000	842	184	79.0	1896	1974

1) Total weight; other nominal sizes, insulating layer thicknesses and trace heating on request.
* When using TYTON or BRS push-in socket joints in exposed pipes, consultation with our Application Technology department is required.

7.6 WKG pipes with BLS push-in socket joint

Wrap fold sleeve for exposed pipes
PE-HD outer sleeve for buried pipes

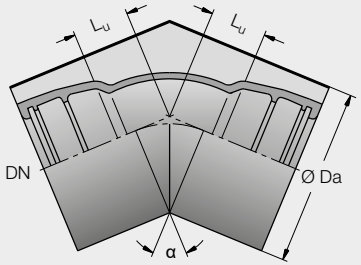


DN	Dimensions [mm]				Weight ~ [kg] 1)	
	Ø Da	Ø d1	L	sD	Exposed pipe	Buried pipe
80	180	98	207	41.0	121	110
100	225	118	215	53.5	149	140
125	250	144	223	53.0	180	171
150	280	170	230	55.0	212	204
200	355	222	240	66.5	300	288
250	400	274	265	63.0	383	378
300	450	326	270	62.0	476	471
400	560	429	290	65.5	705	715
500	710	532	300	89.0	986	1003
600	800	635	280	82.5	1266	1314
700	900	738	302	81.0	1632	1698
800	1000	842	314	79.0	2004	2082

1) Total weight, other nominal sizes, insulating layer thicknesses and trace heating on request.

7.6 WKG elbow sockets (MMK) with TYTON push-in socket joint

or longitudinal positive locking BRS push-in socket joint up to DN 600/wrap fold sleeve for exposed pipes/PE-HD outer sleeve for buried pipes

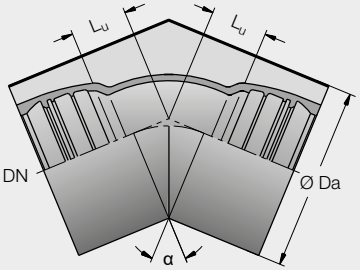


DN	Ø Da	Lu dimensions [mm] MMK 11°	MMK 22°	MMK 30°	MMK 45°	MMQ (90°)
80	180	30	40	45	55	100
100	200	30	40	50	65	120
125	225	35	50	55	75	145
150	250	35	55	65	85	170
200	315	40	65	80	110	220
250	400	50	75	95	130	270
300	450	55	85	110	150	320
400	560	65	110	140	195	430
500	710	75	130	170	240	550
600	800	85	150	200	285	645

Other nominal sizes, insulating layer thicknesses and trace heating on request. Other types of fittings must be insulated on site. *When using TYTON or BRS push-in socket joints in exposed pipes, consultation with our Application Technology department is required.

7.6 WKG elbow sockets (MMK) with BLS push-in socket joint

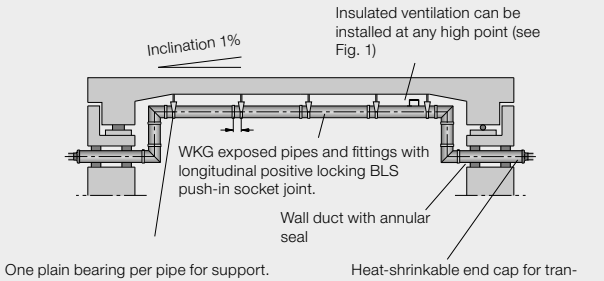
Wrap fold sleeve for exposed pipes
PE-HD outer sleeve for buried pipes



DN	Ø Da	Lu dimensions [mm] MMK 11°	MMK 22°	MMK 30°	MMK 45°	MMQ (90°)
80	180	30	40	45	55	100
100	225	30	40	50	65	120
125	250	35	50	55	75	145
150	280	35	55	65	85	170
200	355	40	65	80	110	220
250	400	50	75	95	130	270
300	450	55	85	110	150	320
400	560	65	110	140	195	430
500	710	75	130	170	240	–
600	800	85	150	200	285	–

Other nominal sizes, insulating layer thicknesses and trace heating on request. Other types of fittings must be insulated on site.

7.6 Example of the installation of a bridge pipeline with WKG exposed pipe system push-in socket joint



Optionally on site:
E.g. S-050 automatic aerator with frost protection hood – made by Airvalve

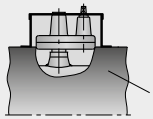
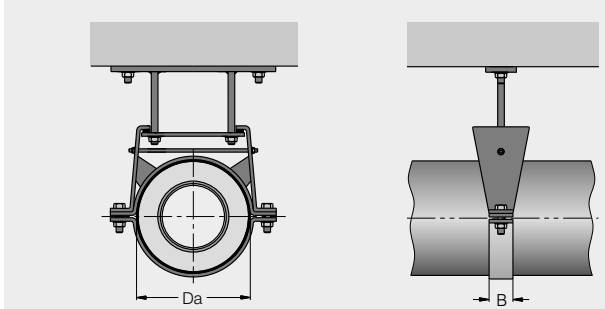


Fig. 1
Manual ventilation (e.g. tapping clamp with 1" or 1.5" universal Hawlinger)

The change in length between the pipeline and the bridge can be compensated for by deflection of the elbows. If you have any questions, please contact our Application Technology department.

7.6 Supports for exposed pipes



Plain bearing with anti-derail device for dowel-mounting or for fixing to brackets, for fixing to bridges, for WKG pipes in accordance with static requirements (e.g. made by Huckenbeck, supplied on site).

Clamp width "W" in mm at spacing of 6 m.

DN	80-125	150-200	250-300	400-500	600-700	800
B	100	150	200	300	400	450

7.6 Downtimes for pipes that are completely filled (water temperature 8 °C)

Exposed pipe wrap fold sleeve
with TYTON push-in socket joint

Medium pipe DN	Insulation thickness [mm] sD	Outside temperature -20 °C		Outside temperature -30 °C	
		Up to 0 °C [h]	Up to 25% ice [h]	Up to 0 °C [h]	Up to 25% ice [h]
80	41.0	10	21	7	14
100	41.0	12	28	9	19
125	40.5	16	39	11	26
150	40.0	20	49	14	32
200	46.5	31	80	22	53
250	63.0	51	135	36	90
300	62.0	62	167	44	111
400	65.5	89	241	63	161
500	89.0	150	410	106	273
600	82.5	172	472	120	315
700	81.0	199	> 500	140	366
800	79.0	224		157	415

In the event of other outside temperatures, please contact our Application Technology department.

7.6 Downtimes for pipes that are completely filled (water temperature 8 °C)

Buried pipe outer sleeve made of PE-HD
with TYTON push-in socket joint

Medium pipe DN	Insulation thickness [mm] sD	Maximum frost depth 1.4 m			
		Cover 0.3 m		Cover 0.5 m	
		Up to 0 °C [h]	Up to 25% ice [h]	Up to 0 °C [h]	Up to 25% ice [h]
80	41.0	24	68	32	102
100	41.0	31	94	41	142
125	40.5	40	130	53	196
150	40.0	49	169	64	254
200	46.5	76	292	100	440
250	63.0	125		164	
300	62.0	151		199	
400	65.5	214		282	
500	89.0	447	> 500		> 500
600	82.5			> 500	
700	81.0	> 500			
800	79.0				

In the event of other frost depths and covers, please contact our Application Technology department.

7.7 Installation instructions for pipes made of ductile cast iron with WKG coating

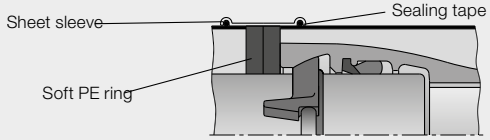
Scope of application
These installation instructions apply to thermally insulated cast-iron pipes and fittings (WKG). For the manufacture of pipe and fitting joints, we refer to the respectively applicable installation instructions for ductile cast-iron pressure pipes with:
– TYTON push-in socket joint,
– longitudinal positive locking BLS push-in socket joint,
– longitudinal positive locking BRS push-in socket joint.

Special instructions for transport and storage
Belts must be used during loading and unloading, transport on the construction site and installation. The pipes may only be put down on wooden beams of at least 10 cm wide or other suitable materials, approx. 1.5 m away from the pipe ends.

They must not
– be set down abruptly,
– be thrown from the vehicle,
– be ground and rolled,
– be stacked.

Laying tools and equipment
– TYTON installation set (angled screwdriver and button)
– Laying tool V 303 for pipes from DN 80 to DN 400, 1)
– Chain hoist or cable pull device for all other nominal sizes.

For pipes with a longitudinal positive locking BLS push-in socket joint, also use a
copper welding jig and
tensioning strap (from DN 600).
Use a chain hoist for BRS push-in socket joints from DN 350



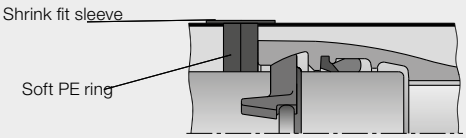
System of exposed pipes (wrap fold sleeve)
Once the joint has been fitted or once it has been fitted and locked, one or more soft polyethylene (SPE) rings are inserted into the remaining gap between the spigot end and the front face of the socket, depending on the type of joint (TYTON, BRS*, BLS). The joint is then sealed with a sheet sleeve. For this purpose, a supplied elastic sealing tape is inserted into the beads of the sheet sleeve on site. The sheet sleeve is fixed in the centre above the joint with tapping screws.

7.7 Installation instructions for pipes made of ductile cast iron with WKG coating

System of buried pipes (outer sleeve made of PE-HD)
Insulation of the gap, as with the exposed pipe system. The joint is then sealed with heat-shrinkable material (shrink bandage). Closed sleeves must be pushed over the pipe shaft before installing the push-in socket joint. Remove grease, dirt and loose particles from the surface to be coated. Using a propane gas flame set to a gentle heat, heat this surface to approx. 60 °C. Remove the adhesive protection film (approx. 150 mm wide) from the shrink fit sleeve.

* When using TYTON or BRS push-in socket joints in exposed pipes, a consultation with our Application Technology department is required.

Fix the free end of the sleeve at right angles to the pipe axis in the centre above the joint and, while simultaneously removing the remaining protective film, place the sleeve loosely around the casing pipe. Overlap of the sleeve min. 80 mm in the easily accessible area of the crown of the pipe.



At low ambient temperatures, it is advisable to briefly heat the inside of the sleeve overlap area and the inside of the closing flap, and to press it on firmly. Heat the closing flap evenly from the outside with a gentle flame while subjecting it to constant movement, until the glass fibre fabric becomes visible. Firmly press the closing flap on by hand (with a glove). Shrink the sleeve with a gentle flame, moving evenly in the circumferential direction.

Shrinking is carried out correctly if:
– The sleeve is completely shrunk,
– it fits smoothly, without cold spots and air bubbles, and the sealing adhesive has been pressed out at both ends of the sleeve,
– the overlap on the casing pipe is at least 50 mm.

The transition from a WKG pipe to ductile cast-iron pipes without thermal insulation occurs using a heat-shrinkable end cap. It is fitted in the same way as the shrink bandages.

7.7 Installation instructions for pipes made of ductile cast iron with WKG coating

Cutting pipes to length
Ensure that the pipes can be cut. Shortened pipes are labelled with a continuous longitudinal line (adhesive tape) on the casing pipe, and with a white "SR" (for 'Schnittrohr', i.e. shortened pipe) stamp on the front end of the socket. Before shortening the medium pipe to the required length, the casing pipe and the PUR rigid foam in the area of the spigot end must be removed. The required length of the spigot end must be transferred from the original pipe or to the pipe section to be shortened. When installing pushovers (EU and U fittings) with screw sockets or gland nut sockets, the larger free space (PUR rigid foam and casing pipe) must be taken into account, depending on the construction situation. Depending on the joint type, the spigot ends must be created in accordance with the corresponding installation instructions.

Please note: Do not damage the heating cable.

Exposed pipe system support
The minimum support and clamp widths for exposed pipes must be observed.

Underground installation of buried pipe system
The pipes must be bedded in accordance with DVGW worksheet W 400-2 and EN 805. In the area of public thoroughfares, the data sheet for filling trenches (Forschungsgesellschaft für das Strassen- und Verkehrswesen e. V (German Road and Transportation Research Association) in Cologne) must be observed. For low cover heights < 0.5 m, load distribution plates must be used above the pipe zone. Our Application Technology department is available if you have any further technical questions.

Trace heating
When using WKG pipes with trace heating, ensure that the heating cable is positioned in the base.

7.8 Introduction
Internal coatings – cement mortar lining

Cement mortar lining
Ductile cast-iron pipes from DUKTUS are always provided with a cement mortar lining (CML) based on blast furnace cement (BFC).
The cement mortar lining of pipes made of ductile cast iron is an integral component of the product. The requirements and test methods are therefore contained in product standard EN 545.

In the centrifugal rotation procedure, the pipe is brought up to a high rotational speed after the fresh mortar is poured (sand-cement-water mix), so that the centrifugal acceleration is at least twenty times the acceleration due to gravity. With this acceleration and through additional vibration forces, the fresh mortar experiences compression and smoothing. During the centrifugal rotation, some of the mixing water is driven out. The surface of the cement mortar lining is enriched with fine grain and fine elements. In ripening chambers, the cement mortar lining is hardened at a defined humidity and temperature. The cement mortar lining of pipes made of ductile cast iron is standardised in EN 545. The thickness of the cement mortar lining is 4 to 6 mm, depending on the nominal size.

How it works
The cement mortar lining offers active and passive protection. The active effect is based on an electrochemical process. Water penetrates the pores of the cement mortar. Here, the water has a pH value above 12 as a result of the absorption of free lime from the mortar. No corrosion is possible on cast iron in this pH range.
The passive effect is achieved from the mechanical separation of cast-iron pipe wall and water.

DN	Layer thickness [mm]		Maximum crack width and maximum radial offset [mm]
	Nominal value	Limit deviation *	
40 to 300	4	-1.5	0.4
350 to 600	5	-2.0	0.5
700 to 1200	6	-2.5	0.6

* only the lower limit dimension is given

7.8 Internal coatings
Cement mortar lining

Applications
Ductile cast-iron pipes with a cement mortar lining based on blast furnace cement can be used for transporting all types of water for human consumption that comply with EU Directive 98/83/EC.
For other types of water, such as untreated water, the application limits are given in the following table, depending on the type of cement used for the lining.

Water characteristic values	Portland cement	Blast furnace cement	High alumina cement
Minimum value for pH	6-12	5.5-12	4-10
Maximum content (mg/l) for:			
– Aggressive CO_2	7	15	Unlimited
– Sulphate (SO_4-)	400	3000	Unlimited
– Magnesium (Mg++)	100	500	Unlimited
– Ammonium (NH_4+)	30	30	Unlimited

Repairing the cement mortar lining
Repairing the cement mortar lining on the construction site
Damaged parts of the cement mortar lining may only be repaired using the repair set provided by the pipe manufacturer.

Contents of the repair set:
– Approx. 5 kg of cement/sand mixture,
– Approx. 1 litre of additive mixture

The contents are specifically intended for use with DUKTUS drinking water pipes. No component must be replaced by any material, or used for cement mortar types other than those specified on the repair set.

Repair instructions
Professional repair is only possible at temperatures above 5 °C. Apart from the repair set, you will need:
Rubber gloves
Dust-proof protective goggles
Wire brush, spatula
Additional mixing vessel
Possibly some drinking water

In the event of substantial damage: Hammer, chisel

7.9 Introduction
POLYURETHANE internal coatings

Properties
Polyurethane is made from a bi-component resin. The three-dimensionally linked molecular structure increases the material's mechanical strength. Polyurethane is a solvent-free duroplastic material. It meets the EN 545, ISO 2531 and EN 598 standards.

Internal coating	DN 80 to DN 200 = 1.3 mm DN 250 to DN 400 = 1.5 mm
Colour	Inside: Green
Density	1.4–1.5 kg/dm³ pore-free coating
Continuity/adhesive strength	At least > 14 MPa
Dielectric resistance	> 108 Ωm²
Temperature	
Water	*40 °C (continuous); up to 80 °C (short-term)*
Air	*120 °C*
Impact resistance	*min. 40 Nm at 20 °C*
Salt spray effect	*after 1000 hours; no effect*
Elongation	*> 10%*
Friction coefficient	*c < 0.01 mm*
Chemical resistance	– Acid/base: pH value of 1 to 14 – Inorganic solvents – Sulphuric acid (wastewater) – *Industrial wastewater*
Thermal expansion	*20 × 10-6 1/K*
Deposits:	*None*

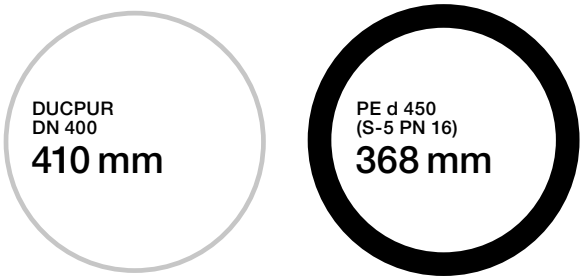
Mechanical properties	Symbol	Unit	Pipes	Fittings
Minimum tensile strength	Rm	MPa	420	420
Yield strength	Rp 0.2	MPa	270	270
Min. elongation at fracture	A	%	10	5
Minimum crush resistance		MPa	550	550
Bursting strength		MPa	300	300
Longitudinal flexural strength		MPa	420	420
Density	I	kg/dm³	7.05	7.05
Elastic modulus	E	MPa	1.7×10^5	1.7×10^5
Thermal expansion coefficient	a	1/K	10×10^{-6}	10×10^{-6}
Hardness		HB	< 230	< 250

Use of chlorine

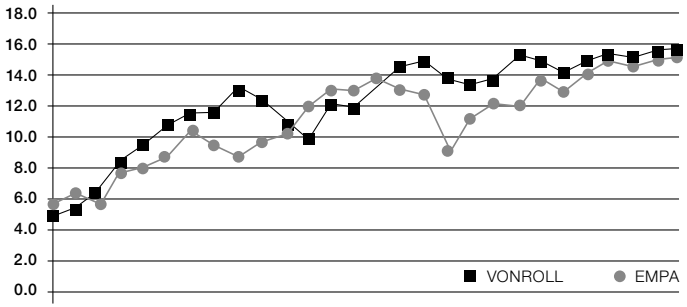
The concentration of chlorine in drinking water and the limited quantity used for disinfection have no effect on the quality of the polyurethane coatings.

Comparison of a hydraulic, usable internal diameter

The integral polyurethane coating significantly improves the hydraulic and mechanical utilisation of your systems. With a very low friction coefficient of k < 0.01 mm. This fact and the thin layer thickness of the polyurethane enable us to achieve the largest pipe cross-section of the supply network. This significantly increases the flow rate and reduces the pressure losses in the pipe. This will minimise the energy consumption of pumps. Under some circumstances, it may even be possible to use a smaller pipe diameter for this reason.



Coated with cast PUR = maximum hydraulically usable internal diameter
(less pump energy required)



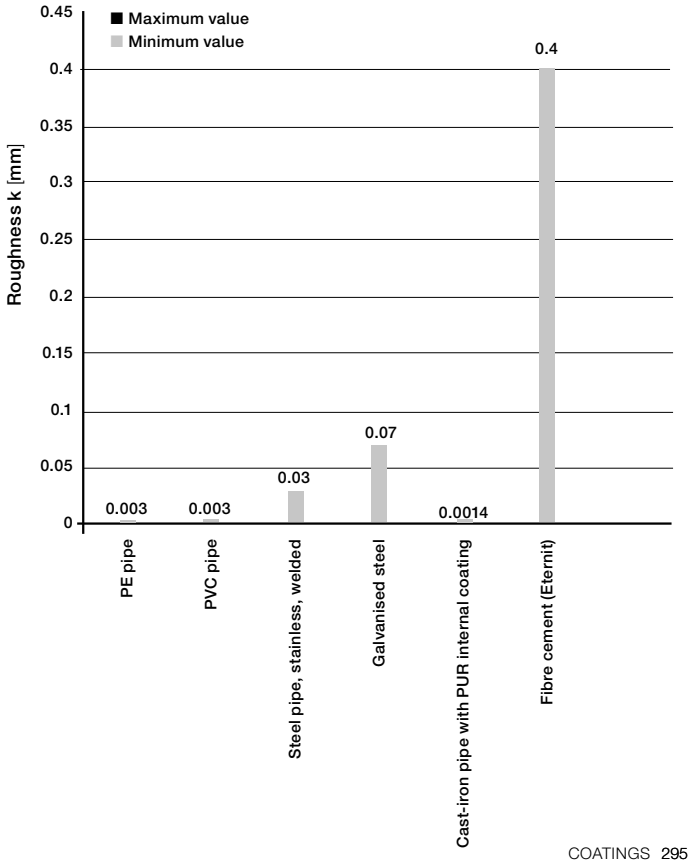
Adhesive strength of PUR coating – comparison of VONROLL and EMPA (target value)

Benefits for the user

The exceptional combination of ductile cast iron and polyurethane (PUR) materials, as well as the proven push-in socket connection technique, possess outstanding properties and offer users the following benefits.

- Long service life
- Cost-effective pipe laying
- Complete corrosion protection
- High mechanical strength
- Ground movement compensation
- Easy to cut to length and bore
- Reduced maintenance costs

Friction coefficient for comparative diagram of pipes



7.10 Introduction
Epoxy fitting coating
(inside and outside)

Layout
As with valves and fittings, the powder coating of fittings with epoxy resin powder is becoming increasingly important. According to EN 545, fittings coated in this way are suitable for substrates of all aggressiveness classes. For this purpose, the fittings are first subjected to surface treatment by blasting (purity grade SA 2.5). The parts are then heated to an object temperature of approx. 200 °C, and dipped in a whirl sinter bath with epoxy resin powder or electrostatically coated using a spray gun. Pore-free layer thicknesses of more than 250 µm are achieved here. Depending on the type of system, the coating process can be automated. The cooled-down fittings are repaired, checked and packaged at the suspension points. The coating of our fittings complies with the specifications of EN 14 901 and the requirements of the "Quality Assurance Association for Heavy-Duty Corrosion Protection" (GSK). Coating with enamel on request.

How it works
The corrosion protection effect is based on the absolutely pore-free epoxy resin coating, which keeps all corrosive influences away from the cast iron. As long as the coating is intact, protection is guaranteed. Damage to the coating must be avoided or repaired as quickly as possible.

Applications
Ductile fittings with an epoxy resin finishing layer in accordance with EN 14901 can be used for the transport of drinking water, service water, surface water, untreated water and wastewater. They can be installed in ground of any corrosiveness in accordance with EN 545. The grain of the filling material should not exceed 0 to 32 mm (round grain) or 0 to 16 mm (broken grain).

Installation instructions
Damage to the external and internal coating must be avoided at all costs. Should damage nevertheless occur, then it must be repaired as quickly as possible. To do this, any loose parts of the coating must be removed and the site of damage repainted with a suitable epoxy resin coating. The reworked area must be hardened before the repaired fitting is installed.

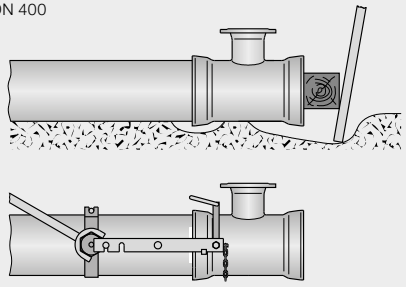
ACCESSORIES

Pipes, fittings

8.1 LAYING TOOLS AND EQUIPMENT

For pipes and fittings with TYTON, BRS and BLS push-in socket joint

Type 1
Lever up to DN 125
Laying tool up to DN 400



The following laying tools and equipment are required for installing pipes and fittings:

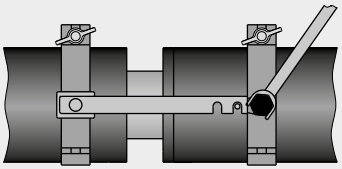
Note: A chain hoist must be used to install the BRS push-in socket joint from DN 350 inclusive.

DN	Pipes	Fittings	
80		MMA, MMB,	Elbow socket:
100	Lever	MMR and	Laying tool
125		EU: Lever	(e.g. type 1)
80	Laying tool		
100			
125	Type 1	As with pipes	
150			
200	Type 2	As with pipes and brackets	
250		With chain of type 1	
300			
350 [1]	Type 3	As with pipes	
400 [1]			
500			
600			
700	Chain hoist	As with pipes	
800			
900			
1000			

1) Use chain hoists for BRS push-in socket joints from DN 350.

8.1 LAYING TOOLS AND EQUIPMENT
For pipes and fittings with TYTON, BRS and BLS push-in socket joint

Type 3



DN	Comprising Type 1	Type 2	Weight [kg] ~
80			13.8
100			14.0
125			15.0
150	One clamp		15.5
200	One fork tool	Two clamps	17.1
250	Two levers	Two levers	18.1
300			20.5
350 [1]			23.5
400 [1]			25.0

1) Use chain hoists for BRS push-in socket joints from DN 350.

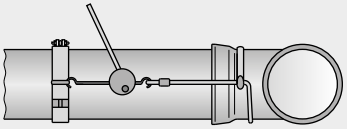
Laying tool type 1 for pipes and fittings from DN 80 to DN 400 with zinc or zinc-aluminium coating and finishing layer (silver marking).

Laying tool type 2 for pipes with cement mortar coating (ZMU, CEMPUR) from DN 80 to DN 400 (blue marking).

Laying tool type 3 for pipes and fittings from DN 80 to DN 400 with thermal insulation (WKG), (red marking).

8.1 LAYING TOOLS AND EQUIPMENT

For pipes and fittings with TYTON, BRS, BLS and HYDROTIGHT push-in socket joints



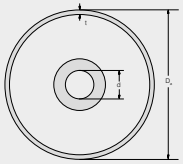
Chain hoist, DN 350 to DN 1000

DN	Comprising	Weight [kg] ~
350 [1]	2 chain hoists, 32 kN 1 rope bracket Pulling rope, 2500 cm 1 mounting clamp	92
400 [1]		97
500		101
600		105
700		108
800		112
900	2 chain hoists, 63 kN 1 rope bracket 1 pulling rope, 4800 cm 1 mounting clamp	115
1000		119

1) Use a chain hoist for BRS push-in socket joints from DN 350.

Equipment:
Hand brush, cleaning cloths, wire brush, spatula, scraper (e.g. bent screwdriver), paintbrush, lubricant, button.

For shortening the pipes:
Abrasive disc cutter with cutting disc for stone, e.g. type 100 EHT (special) or grinding disc for rounding off the spigot end.



Cutting disc for cement mortar coating with depth stop

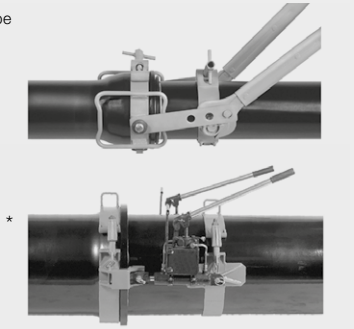
Dimensions [mm]			Weight ~ [kg]
Da	d	t	
115	22.2	3.5	0.7

This cutting disc is used for cutting into the cement mortar coating of pipes. The depth stop effectively prevents accidental cutting into the cast wall.

8.2 LAYING TOOLS AND EQUIPMENT

For pipes and fittings with HYDROTIGHT push-in socket joint

HYDROTIGHT type



*

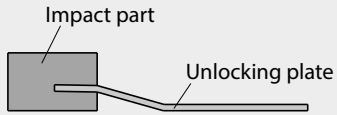
DN	Comprising	Weight [kg] ~
80	Two clamps Two levers	18.7
100		19.0
125		19.2
150		19.5
200		20.5
250		21.0
300		22.5
350 *		52.0
400 *		56.0

* For HYDROTIGHT push-in socket joint from DN 350 with hydraulic laying tool.

Laying tool type HYDROTIGHT for pipes and fittings from DN 80 to DN 400 with zinc or zinc-aluminium coating and PUR finishing layer (ECOP-UR, ECOCEM, DUCPUR).

8.3 DISASSEMBLING TOOLS FOR FRICTIONAL LOCKING JOINT

For pipes and fittings with HYDROTIGHT and BRS push-in socket joint



Disassembling tool

A disassembling tool consists of a carrying anvil and the number of disassembling plates as displayed in the following table.

DN	80	100	125	150	200	250	300	350	400	500	600
Quantity	4	4	5	6	8	10	12	14	15	19	23

8.4 LAYING TOOLS AND EQUIPMENT

For fittings with screw socket and gland nut socket joints

The following laying tools and equipment are required for installing pipes and fittings:

Laying tools:

DN	Screw socket joint	Gland nut socket joint
40	Hook spanner Wooden ram Yarning tool	
50		
65		
80		
100		
125		
150		
200		
250		
300		
350		
400		
500		Ring spanner Hardwood wedges
600		
700		
800		
900		
1000		

Equipment:

Hand brush, wire brush, spatula, chalk, hammer, paintbrush, lubricant.

8.4 LAYING TOOLS AND EQUIPMENT

For fittings with screw socket joint

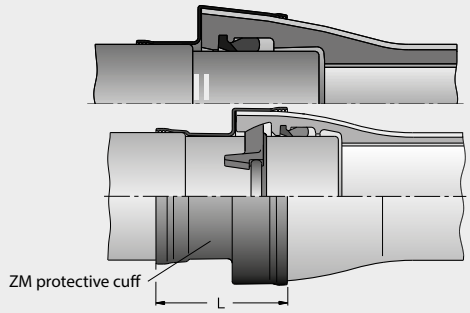
Hook spanner

DN	40	80	100	125	150
Weight ~ [kg]	2.4	3.3	4	5.6	6

DN	200	250	300	350	400
Weight ~ [kg]	7.7	10.5	10.7	16.2	18

8.5 Cement mortar protective sleeves for pipes with cement mortar coating (ZMU, CEMPUR)

TYTON, BRS and BLS push-in socket joint

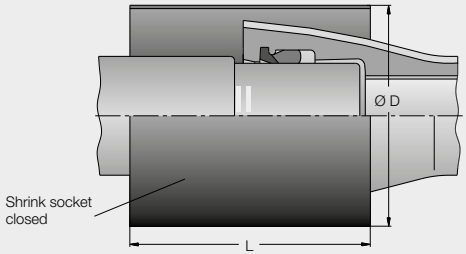


DN	Dimensions [mm] L
80	155
100	155
125	160
150	165
200	170
250	180
300	200
400	210
500	210
600	265
700	265
800	265
900	265
1000	265

These are combination sleeves that fit both TYTON and BRS as well as BLS sockets.

8.5 Shrink-on collar closed for pipes with cement mortar coating (ZMU)

TYTON, BRS or BLS joint
DN 80 to DN 500

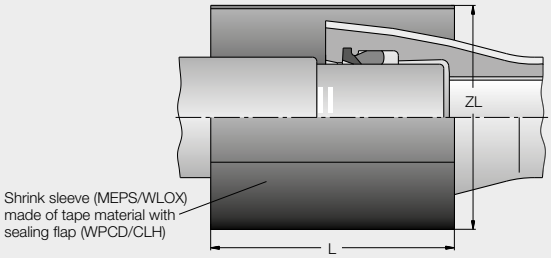


DN	Product designation				Dimensions [mm]	
	Product	Load class	Width "L"	Nominal size (DN)	L	ØD/Ød [1]
80					300	200/80
100					300	235/100
125					300	280/135
150	MPSM	C30	300	DN XXX	300	280/135
200			or		300	340/205
250	PMO	C30	300	DN XXX	300	405/243
300					300	460/275
350					300	515/314
400					300	565/345
500					300	680/414

1) Dia. D/dia. d ~ when not shrunk/maximum shrinkage; dimensions and shrinkage rates may vary slightly depending on the product; from DN 600, open shrink fit sleeves must be used – see next page

8.5 Open shrink fit sleeve, prefabricated with closing flap for pipes with cement mortar coating

(ZMU, ECOPUR, ECOCEM)
DN 600 to DN 1000



Width "L" = 300 mm (12 inches) for TYTON/BRS
Width "L" = 450 mm (17 inches) for BLS

DN	Product designation				Dimensions [mm]
	Product	Load class	Width "L"	Nominal size (DN)	ZL [1]
600	MEPS	C 30	300 or 450	DN XXX	2500
700	Incl. WPCP IV 8x12 or 8x17				2950
800			or		3260
900	WLOX	C 30	300 or 450	DN XXX	3600
1000	Incl. CLH-150-300 or 450				3960

1) Sleeves are already prefabricated to the specified length and provided with a closing flap. Rolled goods of 30 m for DN 250 to DN 1000 on request

HYDRO

9

TRANSPORT, INSTALLATION AND PLANNING

Thorough production controls and final inspections with integrated tightness and strength testing of the pipes and fittings ensure that only faultless material is supplied. Careful treatment of the products during transport, storage and installation is the prerequisite for the drinking water pipes functioning perfectly for many years. We therefore recommend that pipes and fittings are only unloaded and installed under the supervision of a specialist.

Unloading and storing pipes and pipe bundles

Pipes up to DN 350 are supplied together as pipe bundles, and additionally as individual pipes. The exact number of pipes per bundle is listed in the following table. If required, the pipe dimensions can be found in the respective product information.

ZIPOX, ZIPOX+, ZMU, CEMPUR

	Pipes per bundle							
DN	80	100	125	150	200	250	300	350
6 m pipes	15	15	10	6	6	4	4	4

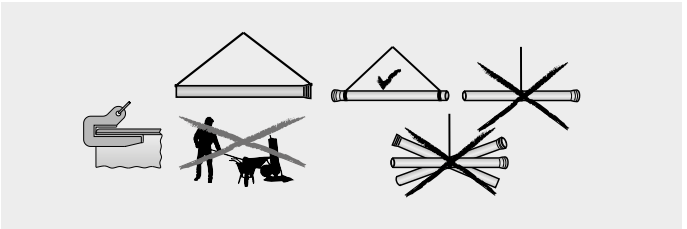
HYDROTIGHT

	Pipes per bundle							
DN	80	100	125	150	200	250	300	350
6 m pipes	15	15	10	6	6	4	4	4

Belts must be used for loading and unloading pipes and pipe bundles with the crane. If individual pipes are unloaded with crane hooks, this must be done with wide and padded hooks that are hooked into the head ends, as otherwise there is a risk of damage to the pipe and its coating. For larger pipes in particular, a shoe adapted to the shape of the pipe must be used.

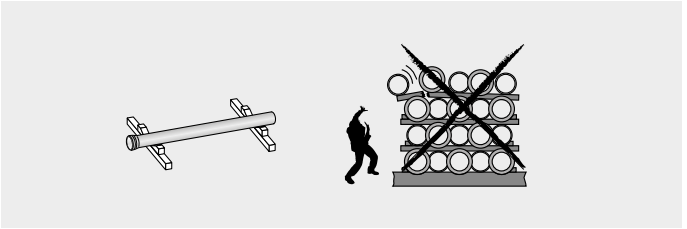
As an alternative to loading and unloading with the crane, suitable forklift trucks can also be used. Particular attention must be paid here to the fact that:
- The pipes cannot tip sideways over the fork (the fork should be at least 1.5 m wide),
- the pipes cannot roll off the fork,
- the fork is sufficiently padded so as to prevent damage to the pipe.

During the loading and unloading process, nobody must be under or on the pipe or pipe bundle, or in the danger zone of the crane. For manual transport of fittings, the covers must first be temporarily removed.

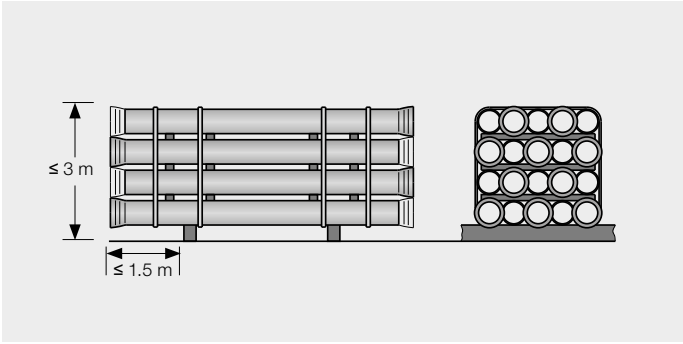


The pipes or pipe stacks may only be put down on wooden beams or other suitable materials.

They should:
- Not be set down abruptly,
- not be thrown from the vehicle,
- not be subjected to grinding or rolled over very long distances,
- be secured against rolling and slipping,
- be stored on a level and load-bearing surface.



If ductile drinking water pipes are stored in a stack, then they must be set down on wooden beams at least 10 cm wide, approx. 1.5 m away from the pipe ends.



DN	Positions
80 – 150	15
200 – 300	10
350 – 600	4
700 – 1000	2

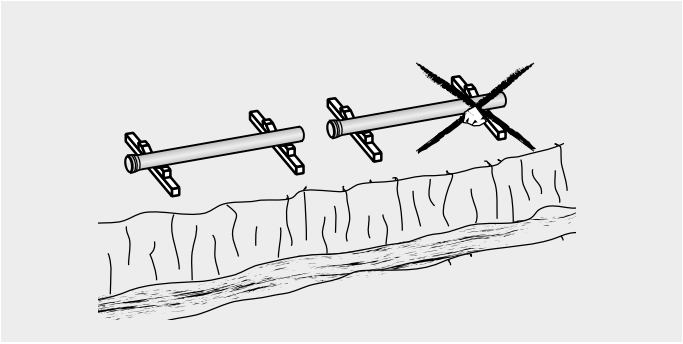
Maximum permissible stacking height

Stacking heights above 3.0 m should be avoided for reasons of accident prevention. Thermally insulated cast-iron pipes (WKG) must not be stacked.

Opening of pipe bundles

The pipe bundles are tied together with steel or plastic strips. The strips may only be cut through with suitable tools, such as snips or a side cutter. Chisels, crowbars, pickaxes and the like can damage the external coating of the pipe, and also pose an increased risk of accidents. Before the steel strips are cut through, it must be ensured that:

- The pipe stack is placed on as level, non-inclined and load-bearing a surface as possible,
- the pipes are secured against rolling and slipping,
- nobody is standing in front of or on the pipe stack.



Distributing the pipes on the construction site

If the pipes are distributed along the trench before installation, they must be supported on wooden beams or similar as already described, and secured against slipping and rolling. The sealing caps of drinking water pipes should only be removed immediately before installation.

Storage of the seal

To ensure the operating safety of the pipe, it is necessary to only install seals that comply with the quality specifications and are supplied by the cast-iron pipe manufacturer. The use of other seals will invalidate any warranty claims. The seals must be stored so that they are cool, dry and not deformed. They must be protected from direct sunlight. Care must be taken to ensure that they are not damaged and do not become dirty.

The seals experience a certain increase in hardness at temperatures below 0 °C. At outside temperatures below 0 °C, the rings must therefore be stored at a temperature above 10 °C to facilitate fitting. The seals should only be removed immediately before fitting the bearing, and must be checked for dirt and damage before installation.

The trench must be constructed in accordance with the existing technical regulations. Please note:
EN 805, EN 1610, EN 18 300, EN 4124, EN 50 929 Part 3, EN 30 675 Part 2, DVGW worksheets W 400-2 and GW 9, ATV-DVWK (German Association for Water, Wastewater and Waste) worksheet A 139 and the data sheet for the filling of trenches.

Installation

The pipes and fittings must be installed in accordance with our installation instructions. The external pipe coating and the pipe embedding material must be selected in accordance with EN 30 675 Part 2.

Pipe coating	Layer thickness	Recommended coating of the pipe joints	Bedding suitable for corrosion protection	Areas of application – ground class
Zinc coating with finishing layer according to EN 545	Zinc 200 g/m²	None	Without	I, II
			With	I, II, III 2)
Zinc-aluminium coating with finishing layer according to EN 545	Zinc-aluminium 400 g/m²	None	Without	I, II, III 2)
Cement mortar coating according to EN 15 542	5.0 mm	Rubber sleeves or heat-shrinkable material or coating in accordance with EN 30 672-B-50M 1) or EN 30 672-C-50M 1)	Without	I, II, III
Polyurethane coating according to EN 15189	0.9 mm	None	Without	I, II, III
EPOXY coating according to EN 14901	250 µm	None	Without	I, II, III

1) At a continuous operating temperature T of 30 °C, the
EN 30 672-B-30M or EN 30 672-C-30M coating for the pipe joint may be used.
2) Not suitable for constant exposure to eluates with pH < 6, as well as for peat, swamp, silty and marshy soils. The information in Section 4.1 of EN 30 675, Part 2, must be observed.

Ground classes I to III must be determined in accordance with DVGW worksheet GW 9 or EN 50 929 Part 3. The following breakdown applies here: Classification of substrates by main groups according to EN 50 929 Part 3.

Valuation number	Ground class	Ground aggressiveness
> 0	I a	Practically not aggressive at all
-1 to -4	I b	Slightly aggressive
-5 to -10	II	Aggressive
< -10	III	Highly aggressive

9.2 Installation,
trenches and pipe bedding

In addition to the aggressiveness of the ground, the grain size also plays a role in the selection of the external pipe coating. DVGW worksheet W 400-2 offers an overview of the permissible grain sizes.

Pipe material	Coating	Grain size – round material	Grain size – broken material
Ductile cast-iron pipes	ZIPOX, ZIPOX+, DUCPUR	0-32 mm Single grains up to max. 63 mm	0-16 mm Single grains up to max. 32 mm
Ductile cast-iron pipes	ZMU, CEMPUR, ECOPUR, ECOCEM	0-63 mm Single grains up to max. 100 mm	0-63 mm Single grains up to max. 100 mm

Filling the trench

The trench in the road must be designed in accordance with the "Data sheet for filling trenches" of the German Road and Transportation Research Association (Forschungsgesellschaft für Straßen- und Verkehrswesen e. V., or FGSV for short) in Cologne, as well as the "Additional technical contract conditions and guidelines for earthworks in road construction" (ZTV E – StB 94).

General cutting ability

In principle, centrifugally cast socket pipes up to and including DN 300 can always be cut. See the following two sections. These must be ordered separately by the customer. From DN 350, socket pipes that can be cut are labelled separately at the plant. For socket pipes > DN 300 that are not identified as capable of being cut, and for F and FF flanged pipes that are made from pipe shafts (can be recognised by a cement mortar lining), it must be checked before cutting whether the requirements that are necessary for this have been met. Cast F and FF flanged pipes (inside and outside epoxy) should not be used as shortened pipes. Socket pipes and flanged pipes can be cut if the external diameter of the pipe shaft at the point to be cut is within the permissible tolerances according to the following table:

DN	Da	Da_{max}	Da_{min}	U_{nenn}	U_{max}	U_{min}
80	98 +1/-2.7	99	95.3	307.9	311.0	299.4
100	118 +1/-2.8	119	115.2	370.7	373.8	361.9
125	144 +1/-2.8	145	141.2	452.4	455.5	443.6
150	170 +1/-2.9	171	167.1	534.1	537.2	525.0
200	222 +1/-3.0	223	219.0	697.4	700.6	688.0
250	274 +1/-3.1	275	270.9	860.8	863.9	851.1
300	326 +1/-3.3	327	322.7	1024.2	1027.3	1013.8
400	429 +1/-3.5	430	425.5	1347.7	1350.9	1336.7
500	532 +1/-3.8	533	528.2	1671.3	1674.5	1659.4
600	635 +1/-4.0	636	631.0	1994.9	1998.1	1982.3
700	738 +1/-4.3	739	733.7	2318.5	2321.6	2305.0
800	842 +1/-4.5	843	837.5	2645.2	2648.4	2631.1
900	945 +1/-4.8	946	940.2	2968.8	2971.9	2953.7
1000	1048 +1/-5.0	1049	1043.0	3292.4	3295.5	3276.7

Da = external diameter; U = circumference

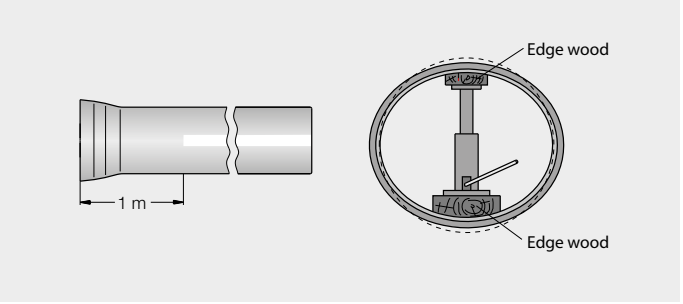
In addition, the ovality at the spigot ends of the pipes must not exceed the following values:
1% for DN 250 to DN 600
2% for DN 600 to DN 1000

E.g.: Ovality = $100 \cdot \left(\frac{738{,}5 - 735}{738{,}5 + 735} \right) = 0{,}24\ \%$

Calculation of ovality

Ovality = $100 \cdot \left(\frac{A_1 - A_2}{A_1 + A_2} \right)$

A_1 = the largest axis in millimetres
A_2 = the smallest axis in millimetres



Cutting ability

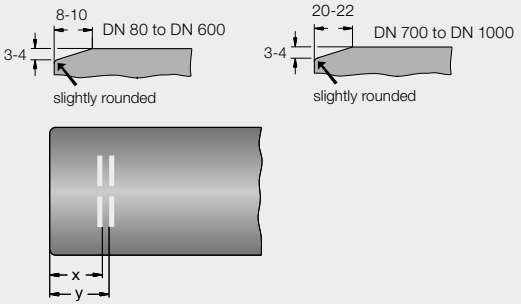
Up to DN 300, the pipes supplied can be cut in the area of the pipe shaft, up to 1 m away from the socket, so that a joint can be produced. Above DN 300, only pipes with a continuous longitudinal line can be cut. Such pipes (shortened pipes) must be ordered separately. An additional indicator of a shortened pipe is an "SR" on the front end of the socket.

Tools

Abrasive disc cutters with various types of drive, such as compressed-air engines, electric motors or petrol engines, are best suited to cutting ductile cast-iron pipes. We recommend type 100 EHT CAST+STONE discs made of corundum and silicon carbide as cutting discs. These are cutting discs for stone that have proven themselves in practice for cutting ductile cast-iron pipes. Protective goggles and respiratory protection must be worn when cutting the cement-mortar-lined or cement-mortar-coated pipes.

Any chips must be carefully removed from the inside of the pipe.
With pipes of larger nominal sizes, the newly created spigot ends may be slightly oval after shortening. If necessary, such spigot ends must be rounded with suitable devices attached to the inside or outside, e.g. hydraulic presses or clamps. The device should only be removed after the joint has been completed.

9.2 Installation
Cutting pipes to length



Processing of cut surfaces

Pipes shortened on the construction site must be chamfered at the cut surfaces to match the original spigot end. Chamfering must be carried out according to the sketch. The bare metal surface is repainted with a coating that matches the external protection of the pipe. A quick-drying finishing layer that meets the requirements of the German Food Law is suitable for this purpose. For faster drying, it is recommended to treat first the pipe ends and then the coating with a gas flame. Then transfer the line markings from the original spigot end to the cut spigot end.

The line marking is omitted for pipes with a BLS joint. A weld bead should be applied here instead. See the BLS installation instructions (Chapter 2) and the technical welding recommendations (Chapter 8) for this. For shortening pipes with a cement mortar coating, the instructions in Chapter 5 must also be observed.

Dimensions for line marking

	DN	80	100	125	150	200	250	300	350
Form A Standard socket	X	69	73	76	79	85	90	95	95
	Y	82	86	89	92	98	103	108	108

	DN	400	500	600	700	800	900	1000
Form A Standard socket	X	95	105	105	–	–	–	–
	Y	108	118	118	–	–	–	–
Form B Long socket	X	–	–	–	148	157	167	177
	Y	–	–	–	161	170	180	190

9.2 Installation
Welding recommendations for manual arc welding

Scope of application

Welding work can be carried out on pipes made of ductile cast iron in accordance with EN 545 in the following cases:

- On water pipes with permissible component operating pressures (PFA) in accordance with EN 545
- Welding on of spigots made of ductile cast iron or DN 2" steel
- Welding on of outputs made of ductile cast iron or steel DN 80 to DN 300
- Puddle flanges for integration into buildings
- Weld beads for longitudinal positive locking push-in socket joints

This recommendation does not apply to polyurethane pipes, fittings and pipeline components produced by sand casting, or to pipeline components made of grey cast iron. Pipes with a minimum wall thickness of less than 4.5 mm must not be welded.

Procedure and electrodes

Manual arc welding is used with nickel-based rod electrodes, preferably those in accordance with EN ISO 1071.

Recommended electrode types

E.g. Castolin 7330-EC; UTP FN 86; ESAB OK 92.58; Gricast 31 or 32. The specifications of the German Welding Society (Deutscher Verband für Schweißtechnik e.V., known as DVS) always apply: DVS 1502, Part 1 and 2; DVS 1148. Welders with DVS 1148 certification must be used. Before carrying out welding work for the first time, seek advice from our Application Technology department.

Preparations for welding

The pipe wall temperatures should not be below + 20 °C during welding. The workplace must be dry. The welding zone must be blanked metal. Impurities or zinc coatings must be removed by filing or grinding. Pinholes must not be welded over. They must be ground down to the base and filled with weld metal. Spigots must be adapted to the external shaft diameter so that the gap does not exceed 0.5 mm if possible.

Carrying out welding work

Current type

Welding can be carried out with direct or alternating current.
The electrode manufacturers' processing guidelines must be observed.

Welding characteristic values

The amperages and welding speeds specified by electrode manufacturers are guide values.

Preheating

Preheating is always advantageous. Before tacking and welding the root layer, the welding area must be preheated in accordance with Table 1.

9.2 Installation
Welding recommendations for manual arc welding

Boundary conditions for crack-resistant welding on pipes made of ductile cast iron.

Welding design	At least two layers (also for pipe/spigot joint)		
Pipe wall thickness (real)	When not filled with water *)		With water flow
	Without cement mortar lining	With cement mortar lining	With cement mortar lining
≥ 4.7 to 6 mm	At 20 °C	At 20 °C	Not approved
6 ... 10 mm	At 20 °C	At 20 °C	At 20 °C **)
10 ... 12 mm	150 °C preheating	At 20 °C	At 20 °C **)
>12 mm	150 °C preheating	150 °C preheating	150 °C preheating

*) Also applies to partially filled pipes in welding areas above the water level
**) Preheating is recommended for pipe wall temperatures below 20 °C

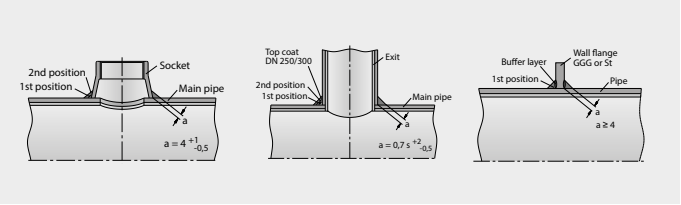
Tacking
Fix the parts to be welded with suitable clamping devices. They must be tacked in at least two places. The outlets of tack welds should be flat so that they can be welded over; this can be achieved by grinding if necessary. The tack welds must be checked to ensure they are free of cracks. Cracked tack welds must be ground.

Welding
Each seam should be welded in a single operation, if possible. Interruptions to work should be avoided. Ensure that the preheating temperature is maintained during welding. If work is interrupted, preheat according to Table 1 before resuming the welding process.

Welding on of spigots made of ductile cast iron or DN 2" steel
The spigots are delivered ready for welding, and can be welded on with fillet welds after pre-treatment of the welding zone and adjustment to the external diameter. The weld seam consists of two layers. The first layer (root) should have an 'a' dimension of 3 mm. The second layer is oscillated between the main pipe and the spigot across the root. The finished seam should be somewhere between flat and slightly hollow. The tightness test is carried out before boring. On water pipes with system test pressure STP (nominal pressure + 5 bar).

Welding on of outputs (cast iron or steel, DN 80 to DN 300)
The nominal size of the outlets must not exceed half the nominal size of the main pipe. The outlets are welded on with fillet welds. Welding is generally carried out using two layers. The first layer (root) should have an 'a' dimension of at least 3 mm. The second layer is initially welded so that it is oscillating between the root and the main pipe, and then so that it is oscillating between the root and the outlet. The finished weld seam should be somewhere between flat and slightly hollow, and have an 'a' dimension of 0.7 s +2/-0.5 mm. For nominal outlet sizes DN 250 and DN 300, an additional top layer can be welded to achieve the 'a' dimension. It can be advantageous to buffer larger outlets. The tightness test is carried out before boring. On water pipes with system test pressure STP (nominal pressure + 5 bar).

9.2 Installation
Welding recommendations for manual arc welding



For new installations, it is recommended that outlets are welded on outside the trench. In this case, the main pipe can be drilled before welding on the outlet. The internal pressure test is then carried out together with the pressure test of the piping.

Welding on of puddle flanges (ductile cast iron or steel)
Pipes with puddle flanges are used for integration into buildings. Welding makes it possible to attach puddle flanges at any point on the pipe shaft. Puddle flanges are supplied as ring segments and must be fitted closely to the pipe.

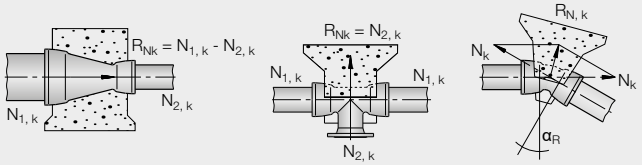
Welding
Puddles flanges are welded on with at least two-layer fillet welds. An 'a' dimension of 4 mm must not be fallen short of here. A buffer layer is recommended for larger nominal sizes with corresponding wall thicknesses. The weld seam length must be determined according to the operational requirements (permissible shear stress τ_{perm} = 130 N/mm^2). Ring segments must be welded together after welding on.

Application of weld beads
For pipes with positive locking/longitudinal positive locking push-in socket joints, the weld beads must be added after shortening on the construction site. The procedure, equipment and dimensional specifications are described in the installation instructions under "Shortening of pipes".

After-treatment
Thermal after-treatment of welded joints or welded parts is not necessary. The seam area must be cleaned after cooling and carefully repainted with a protective coating, for example a bitumen-based coating, after the test.

Testing the weld seams
The weld seams must generally be visually inspected and, if necessary, subjected to non-destructive testing for surface defects and cracks. Weld seams that are not subject to leakage stress, for example on puddle flanges, are checked for surface defects using random samples. Defects found during testing, such as surface pores or cracks in or next to the weld seam, must be completely ground down before repairing. Defects may only be corrected once.

9.3 Planning
Design of concrete abutments
Summary of DVGW worksheet GW 310



Reducer Branch Elbow

Characteristic longitudinal force: $N_K = p \cdot \frac{\pi \cdot d_a^2}{4}$ $[kN]$

This summary for handling on construction sites only applies to force absorption at end closures, changes of direction and branches in the horizontal direction under the following boundary conditions:

- Nominal size DN ≤ 300
- Concrete of quality class C 30/37
- Symmetrical arrangement of the abutment in relation to the line of action of the force to be absorbed (N, RN)
- Load distribution angle in concrete: $2\alpha_K = 90°$
- External temperatures between +10 °C and +30 °C
- Horizontal terrain
- Concreting against undisturbed ground and vertical trench wall
- Foundation depth h of the abutment: 1.0 m ≤ h ≤ 3.0 m
- Abutment height h_T at the trench wall: $\frac{1}{4}h \le h_G \le \frac{2}{3}h$
- Setting time until pressure test: At least three days
- Almost square abutment pressure-loaded area on the trench wall; $h_G \times b_G$
- Groundwater level lower than abutment base

For practical reasons, the values (h_R and b_R) for the pipe/abutment force transmission area are not specified, and it is recommended that the full width of the pipeline component be embedded in the concrete up to the sockets and with sufficient concrete cover. For values outside the above parameters, we refer to DVGW worksheet GW 310, January 2008 edition.

9.3 Planning
Design of concrete abutments
Summary of DVGW worksheet GW 310

Characteristic resultant force:

$R_{N,k} = 2N_k \cdot \sin\frac{\alpha_R}{2} \rightarrow R_{N,k} = N_k \cdot a \quad [kN]$ with $a = 2 \cdot \sin\alpha_R / 2$

(a – see following table)
d_a = pipe external diameter [m]
p = internal pressure (test pressure) [kN/m²] → 1 bar = 100 kN/m²

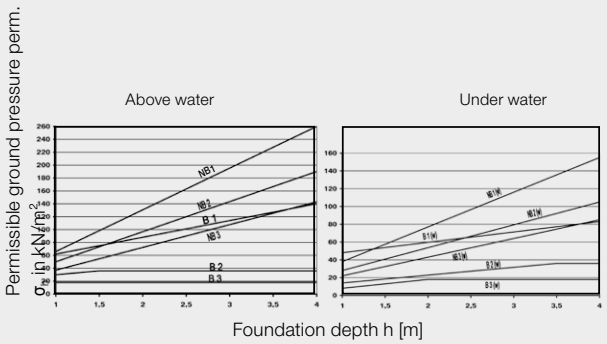
α	11°	22°	30°	45°	End closure and branches	90°
a	0.2	0.4	0.5	0.8	1.0	1.4

The following table shows calculated values of the resulting force $R_{N,k}$ for the most common nominal sizes and elbows, at a test pressure of 15 bar. With these values, it is now possible to calculate the required contact surface of an abutment against the ground.

DN	N_k [kN] (15 bar)	$R_{N,k}$ for elbow angle [kN] 11¼°	22½°	30°	45°	90°
65	7.9	1.5	3.1	4.1	6.1	11.2
80	11.3	2.2	4.4	5.9	8.7	16.0
100	16.4	3.2	6.4	8.5	12.6	23.2
125	22.4	4.8	9.5	12.6	18.7	34.5
150	34.0	6.7	13.3	17.6	26.1	48.1
200	58.1	11.4	22.7	30.1	44.4	82.1
250	88.4	17.3	34.5	45.8	67.7	125.1
300	125.2	24.5	48.9	64.8	95.8	177.1
350	168.3	33.0	65.7	87.1	128.8	238.1
400	216.8	42.5	84.6	112.2	165.9	305.6
500	333.4	65.4	130.1	172.6	255.2	471.5
600	475.0	93.1	185.4	245.9	363.6	671.8
700	641.6	125.8	250.4	332.1	491.1	907.4
800	835.2	163.7	325.9	432.3	639.3	1181.2
900	1052.1	206.2	410.5	544.6	805.2	1478.9
1000	1293.9	253.7	504.9	669.8	990.3	1829.9

$A_G = b_G \cdot h_G$ $[m^2]$ $A_G = \frac{R_{N,k}}{\sigma_{h,w}}$ $[m^2]$
ıe ground:

Perm. $\sigma_{h,w}$ = permissible ground pressure [kN/m²]



Permissible ground pressure perm. $\sigma_{h,w}$ depending on the substrate group and foundation depth h for abutments with a square pressure-loaded area ($h_G/b_G = 1$)

NB1: Natural gravel with sharp edges; gravel or sand, high density
NB2: Sandy gravel or sand, medium density
NB3: Sandy gravel or sand, low density
B1: Till, loam or clay, min. semi-solid consistency (not kneadable)
B2: Loam, silt or clay, min. stiff consistency (difficult to knead)
B3: Loam, silt or clay, min. soft consistency (easy to knead)

The following applies for any test pressure p:

$$A_G = \frac{R_{N,k}}{zul.\sigma_{h,w}} \cdot \frac{p}{15} \quad [m^2]$$

Example:

Pipe	DN 200
Test pressure	p = 30 bar
Ground pressure	perm. $\sigma_{h,w}$ = 50 kN/m²
Curvature angle	$\alpha_k = 30°$

Question: How large must contact surface A_G be against the ground?
$R_{N,k}$ = 30,1 kN

$$A_G = \frac{30{,}1}{50} \cdot \frac{30}{15} \quad [m^2]$$

$$A_G = \underline{1{,}204\, m^2}$$

A calculation tool is also available at www.eadips.org for calculating concrete abutments in accordance with DVGW data sheet 310.

Table for the design of concrete abutments on elbows and branches, calculated for a test pressure of 15 bar and a ground pressure of 100 kN/m²; F = W x H

DN	cm² cm × cm	α = 11°	α = 22°	α = 30°	α = 45°	α = 90°	End closure and branches [1]
80	F	500	500	590	870	1600	1130
	W × H	20 × 25	20 × 25	24 × 25	29 × 30	38 × 42	34 × 34
100	F	500	640	850	1260	2320	1640
	W × H	20 × 25	25 × 26	29 × 30	35 × 36	48 × 49	40 × 41
125	F	500	950	1260	1870	3450	2440
	W × H	20 × 25	30 × 32	35 × 36	43 × 44	58 × 60	49 × 50
150	F	670	1330	1760	2610	4810	3400
	W × H	20 × 25	36 × 37	42 × 42	50 × 52	69 × 70	58 × 59
200	F	1140	2270	3010	4440	8210	5810
	W × H	33 × 35	48 × 48	55 × 55	67 × 67	91 × 91	76 × 77
250	F	1730	3450	4580	6770	12,510	8840
	W × H	42 × 42	59 × 59	68 × 68	82 × 83	112 × 112	94 × 94
300	F	2450	4890	6480	9580	17,710	12,520
	W × H	49 × 50	70 × 77	80 × 81	98 × 98	133 × 133	112 × 112
400	F	4250	8460	11,220	16,590	30,560	21,680
	W × H	65 × 66	92 × 92	106 × 106	129 × 129	175 × 175	147 × 148

1) These values only apply to end closures and branches of the specified nominal size.

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Length of pipe to be secured
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(June 2002 edition)

Forces occur at elbows, branches, end closures and reducers of pipes, the magnitude of which can be determined according to DVGW data sheet GW 310, for example. For pipes with longitudinal positive locking pipe joints, e.g. welded or flange joints, these forces are transmitted through the pipe joint; for pipes with non-longitudinal positive locking joints, e.g. push-in sockets (TYTON joint) or screw sockets, these forces must

- be absorbed by concrete abutments (see GW 310) or
- transferred and diverted to the surrounding ground by establishing the longitudinal positive locking of several sockets (socket securing).

The number of sockets to be secured by creating longitudinal positive locking depends on the test pressure, the nominal size of the pipe and the quality of the trench filling (substrate type, degree of compaction). The forces created by the internal pressure counteract:

- The frictional forces between the pipe wall and the surrounding substrate
- in the case of elbows, branches, end closures and reducers,
- as well as the earth resistance acting on the connecting pipes in the case of elbows.

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Friction coefficient and ground pressure

Friction coefficient μ for the friction between earth and pipe is between 0.1 and 0.6. The following values are recommended:

μ = 0.5	For non-cohesive sands, gravels and tills (substrate types NB1 to NB3 according to GW 310)
μ = 0.25	For very loamy sand, sandy loam, marl, loam, loess or loessic loam and clay with at least a semi-solid consistency (substrate type B1 according to GW 310)
μ = 0.5	For cement mortar coating
μ = 0	If the pipe is installed in groundwater and/or in cohesive soils of soft and stiff consistencies that are difficult to compact (substrate types B2 to B4 according to GW 310). → In this case, it is recommended that the entire pipe is secured with longitudinal positive locking.

Ground pressure

The possible ground pressure depends very much on the degree of compaction of the trench filling in the immediate vicinity of the pipe. The compaction of the trench filling should be at least $D_{pr} = 95\%$. In this case, permissible horizontal ground pressure $\sigma_{h,w}$ values reduced by 50% in accordance with diagram GW 310 can be anticipated.

Notes

In any case, the following must be secured as a minimum:

- For elbows: Two sockets on each side,
- for branches and end closures: Two sockets,
- for reducers: Two sockets on the side with the larger nominal size.

The following tables show the pipe lengths to be secured for ductile cast-iron pipes for various parameters, such as the friction coefficient, ground pressure, pipe cover and system test pressure. When securing elbows against "air", the pipe length to be secured corresponds to that of a branch or end closure (180°). Further calculations can be carried out at **www.eadips.org**.

9.3 Planning
Hydraulic calculations of drinking water pipes

A calculation is necessary to ensure the hydraulic performance of the pipe. High flow velocities lead to considerable pressure losses. Especially with long pressure pipes, the flow velocity has a major influence on the efficiency of the entire supply system. Low flow velocities result in long dwell times (stagnation). Sufficient water exchange must be ensured here for hygienic reasons (water turbidity, contamination).

DVGW worksheets GW 303-1 and W 400-1 are decisive for the hydraulic design of water pipes. W 400-1 specifies the optimum flow velocities depending on the type of pipe (main pipe, connection pipe, etc.). These are essentially between **1.0 m/s and 2.0 m/s.** GW 303-1 includes statements regarding the operational roughness (k2, referred to here as **ki – integral roughness**) of pipe networks. The integral roughness combines all the resistance-forming parts of a pipe or a network, such as wall roughness, socket transitions, deposits, the effect of pipe installations (valves and fittings, elbows, branches, reducers, etc.). The following uniform values have been defined for all pipe materials equally:

ki = 0.1 mm for long-distance pipes and feeder pipes with stretched pipe route
ki = 0.4 mm for pipes with largely stretched pipe route
ki = 1.0 mm for new networks; this approximately takes into account the influence of strong meshing.

The following tables can be used to roughly estimate the flow velocities (v) and pressure losses (I) depending on DN, integral roughness (ki) and flow rate (Q). A free calculation tool for the hydraulic calculation of ductile cast-iron pipes is available for
download at www.eadips.org/online Rechentool (only in German).

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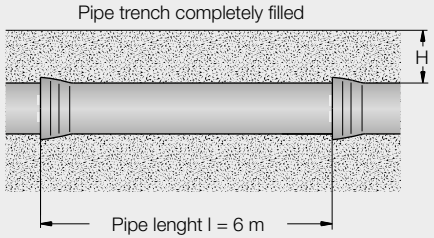

Scope of application
The guidelines of DVGW GW 368 (June 2002 edition) apply to the manufacture and installation of longitudinal positive locking socket joint parts for securing pipe systems and fittings made of ductile cast iron in accordance with EN 545 or EN 28 650 – for supplying water as well as for valves and fittings made of cast iron with spheroidal graphite.

The following tables apply under the following conditions:
- The trench is completely filled up to height H
- The filling material is carefully compacted (D_{pr} = 95%)
- There is no water in the trench

Pipe length L [m] to be secured with the following parameters:
Ground in pipe zone: Ballast, sand or gravel, densely packed (NB1)
Friction coefficient: $\mu = 0.50$
Ground pressure: Perm. $\sigma_{h,w} = 40\ kN/m^2$
Pipe cover: H = 1.00 [m] (trench completely filled)

L [m] at 10 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	12	12	12	12	12	12	12	15	18	22	25	28	31	34
90°	12	12	12	12	12	12	12	12	15	18	21	24	27	30
45°	12	12	12	12	12	12	12	12	12	13	16	19	22	25
30°	12	12	12	12	12	12	12	12	12	12	12	15	18	21
22°	12	12	12	12	12	12	12	12	12	12	12	12	13	16
11°	12	12	12	12	12	12	12	12	12	12	12	12	12	12

L [m] at 15 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	12	12	12	12	13	16	19	24	30	34	39	44	48	52
90°	12	12	12	12	12	12	13	19	24	29	34	38	43	47
45°	12	12	12	12	12	12	12	13	19	24	29	33	38	42
30°	12	12	12	12	12	12	12	12	14	19	24	29	33	38
22°	12	12	12	12	12	12	12	12	12	14	19	24	28	33
11°	12	12	12	12	12	12	12	12	12	12	12	12	12	16

L [m] at 21 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	12	12	12	14	19	23	27	34	41	48	55	61	67	73
90°	12	12	12	12	13	17	21	29	36	43	49	56	62	68
45°	12	12	12	12	12	12	15	23	30	37	44	51	57	63
30°	12	12	12	12	12	12	12	15	25	33	40	46	52	58
22°	12	12	12	12	12	12	12	12	20	27	34	41	48	54
11°	12	12	12	12	12	12	12	12	12	12	16	23	29	36

L [m] at 30 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600
180°	12	15	18	21	27	32	38	49	59	69
90°	12	12	12	14	20	26	32	43	53	63
45°	12	12	12	12	15	24	29	38	48	58
30°	12	12	12	12	12	15	21	32	43	53
22°	12	12	12	12	12	12	16	27	38	48
11°	12	12	12	12	12	12	12	12	18	29

L [m] at 45 bar test pressure

DN / Elbow	80	100	125	150	200	250	300
180°	18	22	26	31	40	49	57
90°	12	16	20	25	34	43	51
45°	12	12	14	19	28	37	45
30°	12	12	12	14	23	32	40
22°	12	12	12	12	17	26	35
11°	12	12	12	12	12	12	14

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Length of pipe to be secured
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Pipe length L [m] to be secured with the following parameters:
Ground in pipe zone: Very loamy sand, sandy loam, loam, clay, marl (B1)
Friction coefficient: $\mu = 0.25$
Ground pressure: Perm. $\sigma_{h,w} = 30\,kN/m^2$
Pipe cover: H = 1.00 [m] (trench completely filled)

L [m] at 10 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	12	12	12	13	17	21	24	32	39	45	52	58	63	69
90°	12	12	12	12	12	15	18	26	33	40	46	53	58	64
45°	12	12	12	12	12	12	12	18	25	32	39	45	51	57
30°	12	12	12	12	12	12	12	12	17	25	31	38	44	50
22°	12	12	12	12	12	12	12	12	15	17	24	30	37	43
11°	12	12	12	12	12	12	12	12	12	12	12	12	12	16

L [m] at 15 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	12	15	18	21	27	32	38	49	59	69	78	87	96	104
90°	12	12	12	13	19	25	31	42	52	62	71	81	89	97
45°	12	12	12	12	12	16	22	32	44	54	64	73	82	90
30°	12	12	12	12	12	12	14	26	37	47	57	66	75	84
22°	12	12	12	12	12	12	12	17	29	39	49	59	68	77
11°	12	12	12	12	12	12	12	12	12	12	22	31	41	50

L [m] at 21 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	17	20	25	29	37	45	53	68	83	96	110	122	134	145
90°	12	13	17	21	30	38	46	61	76	90	103	115	127	139
45°	12	12	12	12	21	29	37	53	68	82	95	108	120	132
30°	12	12	12	12	13	21	29	45	60	74	88	101	113	125
22°	12	12	12	12	12	13	21	37	52	67	80	94	106	120
11°	12	12	12	12	12	12	12	18	22	38	52	66	79	92

L [m] at 30 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600
180°	23	28	34	41	53	64	76	98	118	138
90°	17	22	28	34	47	58	70	92	113	132
45°	12	13	19	25	38	50	61	84	105	125
30°	12	12	12	17	30	42	53	76	97	118
22°	12	12	12	12	21	33	45	68	89	110
11°	12	12	12	12	12	12	14	37	59	81

L [m] at 45 bar test pressure

DN / Elbow	80	100	125	150	200	250	300
180°	35	43	52	61	80	97	114
90°	29	36	46	55	73	91	108
45°	20	27	37	46	65	82	100
30°	12	19	29	38	57	74	92
22°	12	12	20	29	48	66	83
11°	12	12	12	12	16	34	52

9.3 Planning
Length of pipe to be secured
Summary of DVGW worksheet GW 368

Pipe length L [m] to be secured with the following parameters:
Ground in pipe zone: Very loamy sand, sandy loam, loam, clay, marl (B1)
Friction coefficient: $\mu = 0.50$
Ground pressure: Perm. $\sigma_{h,w} = 30\ kN/m^2$
Pipe cover: H = 1.00 [m] (trench completely filled)

L [m] at 10 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	12	12	12	12	12	12	12	15	19	22	25	28	31	34
90°	12	12	12	12	12	12	12	12	16	19	23	26	29	32
45°	12	12	12	12	12	12	12	12	12	15	19	22	25	28
30°	12	12	12	12	12	12	12	12	12	12	15	18	22	25
22°	12	12	12	12	12	12	12	12	12	12	12	15	18	21
11°	12	12	12	12	12	12	12	12	12	12	12	12	12	12

L [m] at 15 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	12	12	12	12	12	15	18	24	29	34	39	43	47	52
90°	12	12	12	12	12	12	15	21	26	31	36	40	45	49
45°	12	12	12	12	12	12	12	16	22	27	32	37	41	45
30°	12	12	12	12	12	12	12	13	18	23	28	33	38	42
22°	12	12	12	12	12	12	12	12	14	19	25	29	34	39
11°	12	12	12	12	12	12	12	12	12	12	12	16	20	25

L [m] at 21 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	12	12	12	13	18	22	26	33	41	48	54	61	67	73
90°	12	12	12	12	15	19	23	30	38	45	52	58	64	70
45°	12	12	12	12	12	14	19	26	34	41	48	54	60	66
30°	12	12	12	12	12	12	15	23	30	37	44	51	57	63
22°	12	12	12	12	12	12	12	18	26	33	40	47	53	60
11°	12	12	12	12	12	12	12	12	12	19	26	33	40	46

L [m] at 30 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600
180°	12	13	16	20	26	32	37	48	59	69
90°	12	12	13	16	23	28	34	45	56	66
45°	12	12	12	12	18	24	30	41	52	62
30°	12	12	12	12	14	20	26	37	48	58
22°	12	12	12	12	12	16	22	33	44	54
11°	12	12	12	12	12	12	12	18	29	40

L [m] at 45 bar test pressure

DN / Elbow	80	100	125	150	200	250	300
180°	17	21	25	30	39	48	57
90°	14	18	22	27	36	45	54
45°	12	13	18	23	32	41	49
30°	12	12	14	18	28	37	45
22°	12	12	12	14	23	32	41
11°	12	12	12	12	12	16	26

9.3 Planning
Length of pipe to be secured
Summary of DVGW worksheet GW 368

Pipe length L [m] to be secured with the following parameters:
Ground in pipe zone: Ballast, sand or gravel, densely packed (NB1)
Friction coefficient: $\mu = 0.50$
Ground pressure: Perm. $\sigma_{h,w} = 40\,kN/m^2$
Pipe cover: H = 1.50 [m] (trench completely filled)

L [m] at 10 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	12	12	12	12	12	12	12	12	13	15	18	20	22	25
90°	12	12	12	12	12	12	12	12	12	13	15	18	20	22
45°	12	12	12	12	12	12	12	12	12	12	12	14	16	19
30°	12	12	12	12	12	12	12	12	12	12	12	12	13	15
22°	12	12	12	12	12	12	12	12	12	12	12	12	12	12
11°	12	12	12	12	12	12	12	12	12	12	12	12	12	12

L [m] at 15 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	12	12	12	12	12	12	12	16	20	24	27	31	34	37
90°	12	12	12	12	12	12	12	13	17	21	25	28	31	35
45°	12	12	12	12	12	12	12	12	13	17	21	24	28	31
30°	12	12	12	12	12	12	12	12	12	14	18	21	25	28
22°	12	12	12	12	12	12	12	12	12	12	14	18	21	25
11°	12	12	12	12	12	12	12	12	12	12	12	12	12	12

L [m] at 21 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	12	12	12	12	12	15	18	23	28	33	38	43	48	52
90°	12	12	12	12	12	12	15	20	26	31	36	41	45	50
45°	12	12	12	12	12	12	12	16	22	27	32	37	42	46
30°	12	12	12	12	12	12	12	12	18	24	29	34	38	43
22°	12	12	12	12	12	12	12	12	15	20	25	30	35	40
11°	12	12	12	12	12	12	12	12	12	12	12	17	22	27

L [m] at 30 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600
180°	12	12	12	13	17	21	25	33	41	48
90°	12	12	12	12	15	19	23	31	38	45
45°	12	12	12	12	12	15	19	27	34	42
30°	12	12	12	12	12	12	15	23	31	38
22°	12	12	12	12	12	12	12	19	27	35
11°	12	12	12	12	12	12	12	12	13	21

L [m] at 45 bar test pressure

DN / Elbow	80	100	125	150	200	250	300
180°	12	12	17	20	27	32	39
90°	12	12	14	17	24	30	36
45°	12	12	12	13	20	26	32
30°	12	12	12	12	16	22	29
22°	12	12	12	12	12	18	25
11°	12	12	12	12	12	12	12

9.3 Planning
Length of pipe to be secured
Summary of DVGW worksheet GW 368

Pipe length L [m] to be secured with the following parameters:
Ground in pipe zone: Very loamy sand, sandy loam, loam, clay, marl (B1)
Friction coefficient: $\mu = 0.25$
Ground pressure: Perm. $\sigma_{h,w} = 30\,kN/m^2$
Pipe cover: H = 1.50 [m] (trench completely filled)

L [m] at 10 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	12	12	12	12	12	14	17	22	27	32	37	41	46	50
90°	12	12	12	12	12	12	13	18	23	28	33	38	42	46
45°	12	12	12	12	12	12	12	13	18	23	28	32	37	41
30°	12	12	12	12	12	12	12	12	12	17	22	27	32	36
22°	12	12	12	12	12	12	12	12	12	12	17	22	26	31
11°	12	12	12	12	12	12	12	12	12	12	12	12	12	12

L [m] at 15 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	12	12	12	13	18	22	26	34	41	48	56	62	69	75
90°	12	12	12	12	12	13	18	22	30	37	45	52	59	65	72
45°	12	12	12	12	12	12	16	24	32	39	46	53	60	67
30°	12	12	12	12	12	12	12	18	26	34	41	48	55	62
22°	12	12	12	12	12	12	12	13	21	28	36	43	50	57
11°	12	12	12	12	12	12	12	12	12	12	19	23	30	37

L [m] at 21 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	12	13	16	19	25	31	36	47	58	68	78	88	97	106
90°	12	12	13	15	21	27	32	43	54	64	74	84	93	102
45°	12	12	12	12	15	21	26	38	48	59	69	79	88	97
30°	12	12	12	12	12	15	21	32	43	54	64	74	83	92
22°	12	12	12	12	12	12	15	27	37	48	58	68	78	87
11°	12	12	12	12	12	12	12	12	17	37	38	48	58	68

L [m] at 30 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600
180°	16	19	23	28	36	44	52	68	83	98
90°	12	15	19	23	32	40	48	64	79	94
45°	12	12	13	17	26	34	42	58	73	88
30°	12	12	12	12	20	29	37	53	68	83
22°	12	12	12	12	14	23	31	47	63	78
11°	12	12	12	12	12	12	12	26	42	57

L [m] at 45 bar test pressure

DN / Elbow	80	100	125	150	200	250	300
180°	24	29	36	42	54	67	79
90°	20	25	31	38	50	63	75
45°	14	19	25	32	44	57	69
30°	12	13	20	26	39	51	64
22°	12	12	14	20	33	45	58
11°	12	12	12	12	12	24	36

9.3 Planning
Length of pipe to be secured
Summary of DVGW worksheet GW 368

Pipe length L [m] to be secured with the following parameters:
Ground in pipe zone: Very loamy sand, sandy loam, loam, clay, marl (B1)
Friction coefficient: $\mu = 0.50$
Ground pressure: Perm. $\sigma_{h,w} = 30\ kN/m^2$
Pipe cover: H = 1.50 [m] (trench completely filled)

L [m] at 10 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	12	12	12	12	12	12	12	12	13	16	18	20	23	25
90°	12	12	12	12	12	12	12	12	12	14	16	18	21	23
45°	12	12	12	12	12	12	12	12	12	12	13	16	18	20
30°	12	12	12	12	12	12	12	12	12	12	12	13	16	18
22°	12	12	12	12	12	12	12	12	12	12	12	12	13	15
11°	12	12	12	12	12	12	12	12	12	12	12	12	12	12

L [m] at 15 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	12	12	12	12	12	12	13	16	20	24	28	31	34	38
90°	12	12	12	12	12	12	12	14	18	22	26	29	32	36
45°	12	12	12	12	12	12	12	12	15	19	23	26	30	33
30°	12	12	12	12	12	12	12	12	13	17	20	24	27	31
22°	12	12	12	12	12	12	12	12	12	14	18	21	25	28
11°	12	12	12	12	12	12	12	12	12	12	12	12	15	18

L [m] at 21 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600	700	800	900	1000
180°	12	12	12	12	12	15	18	23	29	35	39	44	48	53
90°	12	12	12	12	12	13	16	21	27	32	37	42	46	51
45°	12	12	12	12	12	12	13	18	24	29	34	39	44	48
30°	12	12	12	12	12	12	12	16	21	26	32	36	41	46
22°	12	12	12	12	12	12	12	13	18	24	29	34	38	43
11°	12	12	12	12	12	12	12	12	12	13	19	24	29	34

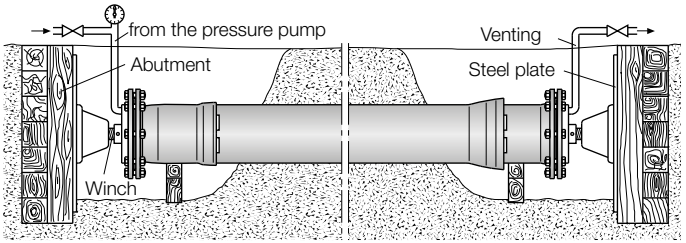
L [m] at 30 bar test pressure

DN / Elbow	80	100	125	150	200	250	300	400	500	600
180°	12	12	12	13	18	22	26	34	41	49
90°	12	12	12	12	16	20	24	32	39	47
45°	12	12	12	12	13	17	21	29	36	44
30°	12	12	12	12	12	14	18	26	34	41
22°	12	12	12	12	12	12	15	23	31	38
11°	12	12	12	12	12	12	12	13	21	28

L [m] at 45 bar test pressure

DN / Elbow	80	100	125	150	200	250	300
180°	12	14	17	21	27	33	39
90°	12	12	15	18	25	31	37
45°	12	12	12	15	22	28	34
30°	12	12	12	13	19	25	31
22°	12	12	12	12	16	22	29
11°	12	12	12	12	12	12	18

9.3 Planning
Pressure test



According to EN 805, pipes must be subjected to an internal pressure test. EN 805 and DVGW worksheet W 400-2 are decisive when it comes to carrying out testing of water pipes.

Test sections
If necessary, longer pipes should be divided into partial sections. The test sections must be defined in such a way that

- the test pressure is reached at the lowest point of each test section
- at least 1.1 times the system test pressure (MDP) is reached at the highest point of each test section
- the required amount of water for the pressure test can be provided and drained
- the maximum test length does not exceed 2.5 to 3 km.

The pipe must be vented as well as possible, if necessary by "pigging", and filled with drinking water starting from the low point.

Filling and securing
If necessary, pipes must be covered with filling material before the pressure test in such a way that changes in position are avoided. Filling the joints is optional. Non-longitudinal positive locking pipes must be anchored against the forces caused by internal pressure at the ends, elbows, branch pipes and reducers. The abutments required for this are designed in accordance with GW 310. The installation of abutments can be omitted for systems with longitudinal positive locking, provided that the length to be secured per installation case in accordance with GW 368 is adhered to. Performing the pressure test against a closed shut-off valve is not practical. The temperature on the outside wall of the pipe must be kept as constant as possible and must not exceed 20 °C.

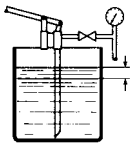
Filling the pipe

It is expedient to fill the pipe starting from the pipe's low point, in such a way that the air contained in the pipe can escape easily at the sufficiently large venting points of the pipe's high points.

The following filling quantities in l/s are recommended:

DN	100	150	200	250	300	400	500	600	700	800	900	1000
Filling quantity	0.3	0.7	1.5	2	3	6	9	14	19	25	32	40

For drinking water pipes, initial disinfection should be carried out in conjunction with the pressure test, for which a concentration of at least 50 mg of chlorine per litre of water is required. Depending on the degree of soiling, the chlorine content can be increased up to 150 mg per litre of water. The ratio of the amount of water added compared with the achieved pressure increase can provide an indication of leaks or inadequate venting. Therefore, the water consumption should be noted from bar to bar when increasing the pressure.



bar	mm	In litres
0-1		
1-2		
2-3		
3-4		
5-6		

Water consumption for 1 bar

If the pipe is correctly laid and vented, the amount of water to be pumped back in per bar of pressure increase is approximately constant. It is (theoretically) approx. 50 ml/m^3 of pipe capacity/bar, taking into account the compressibility of the water and the elastic behaviour of the pipe. In practice, this value is 1.5 to 2.0 times higher, as trapped air in the pipe and fitting joints and in the valves and fittings has to be compressed.

Implementation of the pressure test

The following procedures are described in DVGW worksheet W 400-2 for carrying out the pressure test on ductile cast-iron pipes:

- Standard procedure (for all DN with and without cement mortar lining)
- Accelerated standard procedure (up to DN 600, with cement mortar lining)

The two most frequently used procedures, i.e. the standard procedure and the accelerated standard procedure, are described below. The test pressure level for both procedures is:

- For pipes with a permissible operating pressure of up to 10 bar: 1.5 × nominal pressure
- For pipes with a permissible operating pressure of over 10 bar: Nominal pressure +5 bar.

The standard procedure

The standard procedure is carried out in three phases:
- Preliminary test
- Pressure drop test
- Main test

Preliminary test

The preliminary test serves to saturate the cement mortar lining and to stretch the pipe. To achieve this, the test pressure is kept constant for a period of 24 hours by constant repumping. If impermissible changes in position or leaks occur, the pipe must be depressurised and the cause rectified.

Pressure drop test

The pressure drop test is used to determine whether the pipe is free of air. Trapped air in the pipe can lead to incorrect measurement results or cover up small leaks. A volume of water (ΔV) is removed from the pipe until a pressure drop (Δp) of at least 0.5 bar is reached. The removed water volume (ΔV) is measured. The test pressure is then restored.

The pipe is considered to be sufficiently vented if ΔV is not greater than ΔV_{perm}. Otherwise, the pipe must be vented again.

ΔVperm is calculated as follows: $\Delta V_{zul} = 1{,}5 \cdot a \cdot \Delta p \cdot L$

ΔV_{perm} = permissible volume change [cm^3]
Δp = measured pressure drop [bar]
L = length of the tested section [m]
a = pressure constant that denotes the pipe type [$cm^3/(bar \times m)$]
→ See the following table

DN	a	DN	a
80	0.314	400	9.632
100	0.492	500	15.614
125	0.792	600	23.178
150	1.163	700	32.340
200	2.147	800	43.243
250	3.482	900	55.679
300	5.172	1000	69.749
350	7.147	1200	103.280

Main test

The main test is carried out after the pressure drop test. When it comes to the test duration, the following values apply:

Up to	**DN 400**	3 h
	DN 500 to DN 700	12 h
Over	**DN 700**	24 h

The test conditions are considered to be fulfilled if the pressure drop at the end of the test is not greater than specified below:

Nominal pressure	Test pressure	Maximum pressure drop
10	15 bar	0.1 bar
16	21 bar	0.15 bar
Over 16	PN + 5 bar	0.2 bar

Test report

A test report must be prepared. Templates for test reports are included in DVGW worksheet W 400-2. They contain the necessary information, such as:

- Description of the pipe
- Test data
- Implementation of the test
- Findings during the test
- Test statement

The accelerated standard procedure

The main advantage of the accelerated standard procedure is the enormous time saving. The time required is only approx. 1.5 hours. The accelerated standard procedure is carried out in three phases:
1. Saturation phase; 2. Pressure drop test; 3. Tightness test

Saturation phase

To achieve a high degree of saturation, the test pressure is kept constant for half an hour by constant repumping. Saturation is primarily determined by the level of the test pressure. If the pressure is too low, it cannot be compensated for by extending the saturation phase.

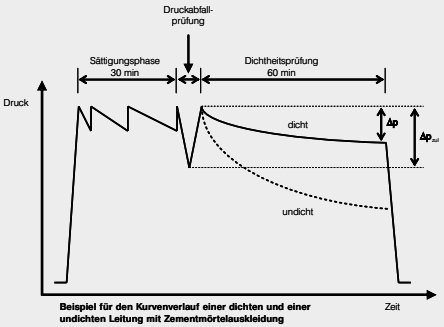
Pressure drop test

The pressure drop test is used to determine whether the pipe is free of air. Trapped air in the pipe can lead to incorrect measurement results or cover up small leaks. A volume of water (ΔVperm) is taken from the pipe at the test pressure. The resulting pressure drop (Δp) is measured. This is the permissible pressure drop Δp_{perm} in the subsequent tightness test. The test pressure must be restored after the pressure drop test.

ΔV_{perm} is calculated as follows: $\Delta V_{zul} = (DN \cdot L)/(100 \cdot k)$

ΔV_{perm} = permissible volume change [cm^3]
L = length of the tested section = [m]
$100 \times k$ = proportionality factor, $k = 1\,m/cm^3$

The pipe is considered to be sufficiently vented if the pressure drop is greater than or equal to the limit values for Δp specified in the following table when the ΔVperm water volume is removed.



Beispiel für den Kurvenverlauf einer dichten und einer undichten Leitung mit Zementmörtelauskleidung

Nominal size DN	Minimum pressure drop Δp [bar]
80	1.4
100	1.2
150	0.8
200	0.6
250	0.5
300	0.4
350	0.35
400	0.3
500	0.2
600	0.1

Tightness test

The pipe is considered to be leaktight if the pressure drop Δp decreases continuously in equal time intervals and does not exceed the value Δpperm determined in the pressure drop test over the duration of the tightness test. The test takes one hour.

Test report

A test report must be prepared. Templates for test reports are included in DVGW worksheet W 400-2. They contain the necessary information, such as:

- Description of the pipe
- Test data
- Implementation of the test
- Findings during the test
- Test statement

The disinfection measures concern both the drinking water itself and all the drinking water supply systems. The disinfection effect can be achieved with various disinfectants and different disinfection methods. The disinfection of a pipe is only deemed to have been successfully completed once impeccable test results are available.

General information

Water supply companies must provide drinking water of a hygienically faultless quality. These requirements are set out in the German Food, Commodities and Feed Code, the German Infection Protection Act and the German Drinking Water Ordinance. Drinking water must then be of such a quality that its consumption is not harmful to health. A prerequisite for this is that the drinking water pipe is in a hygienically faultless condition. This is achieved by disinfecting the drinking water pipe. Disinfection includes all measures that reduce the bacterial count in such a way that the quality of the water transported in the pipes is not impaired. These disinfection measures relate to the drinking water, but also to the water supply systems. According to the German Food Law, the pipes are "commodities that are used when putting drinking water into circulation, and thereby come into contact with it".

Drinking water pipes must be disinfected in accordance with DVGW worksheet W 291. For pipes made of ductile cast iron with a cement mortar lining, it is expedient to carry out the disinfection at the same time as the pressure test. When constructing drinking water pipes, it must be ensured that contamination in the pipes that will later carry water is excluded as far as possible from the outset. Contamination from personnel and tools (dirty cloths for wiping out the socket, etc.) and the introduction of pollutants through the air (oily exhaust mist from two-stroke pipe cutters) must be ruled out. The ends of pipes must be sealed so tightly that neither groundwater/dirty water nor animals can get through.

Disinfection must be ensured in the following cases:

- Before commissioning drinking water pipes
- After repairs and work on the pipe network
- In case of stagnation of the drinking water
- In case of contamination of drinking water pipes

Flushing of drinking water pipes

According to DVGW worksheet W 291, flushing with drinking water is usually sufficient as the simplest means of reducing the concentration of bacteria in pipes of small nominal sizes up to DN 150. This may make additional disinfection superfluous.

When flushing, a sufficient flow velocity (at least 1.5 m/s) must be ensured. The flushing effect can be enhanced by simultaneous pigging or by flushing with a water/air mixture. At least 3–5 times the pipe capacity (for ≤ DN 150) and 2–3 times the pipe capacity (≥ DN 200) should be available as a flushing water volume.

Please note the following when flushing:

- Only equipment that is suitable for drinking water and has been flushed and, if possible, disinfected, e.g. hoses, may be used.
- Inclined pipes are flushed from top to bottom.
- Injected air must be free of oil and dust.
- Water from the flushing section must not enter the supply network or reach the consumers.
- There must be no impermissible pressure drop in the supply network.
- When emptying, there must be no possibility of dirty water being sucked back in.
- After flushing with an air/water mixture, the pipe must be properly vented.

Disinfectant

The choice of disinfectant must be made according to local conditions. For example, proper handling and effective action of the disinfectant must be ensured here, and its removal must be guaranteed. The following agents are most frequently used to disinfect drinking water pipes:

Sodium hypochlorite, potassium permanganate, hydrogen peroxide and chlorine dioxide. Based on the test in accordance with the German Hazardous Substances Ordinance, the use of disinfectants containing chlorine must be critically noted. If disinfectants cannot be dispensed with, hydrogen peroxide and potassium permanganate should be used in the first instance. Both agents can be used as working solutions in concentrations below the source of the hazardous substance. *(Schlicht, bbr 2/2003)*

Sodium hypochlorite (NaOCl)

Sodium hypochlorite is the most widely used disinfectant. It is commercially available as a sodium hypochlorite solution (chlorine bleach). The solution should have a free chlorine content of at least 12% (150 to 160 g chlorine/l). It should be noted here that the free chlorine content consistently decreases during storage of the solution. It should therefore be checked after prolonged storage. A tried-and-tested disinfectant solution for cast-iron pipes with a cement mortar lining has a concentration of 50 mg of chlorine per litre of water, for example. For post-chlorination, a higher concentration (up to approx. 150 mg of chlorine per litre of water) is recommended.

The pH value of the sodium hypochlorite solution is between11.5 and 12.5. When disinfecting a pipe, such a solution inevitably increases the pH value of the treated water. It is not advisable to lower the pH value by mixing the solution with acids, because chlorine gas may escape and cause an accident. A mixture with very hard water can lead to the sedimentation of calcium carbonate. Disinfectant solutions containing chlorine must always be treated so as to render them harmless before being discharged into the sewage system or a body of water. This can be done by dilution or by chemical neutralisation with sodium thiosulphate. Furthermore, dechlorination is possible through filtration via activated carbon filters.

Hydrogen peroxide (H_2O_2)

Hydrogen peroxide is a colourless liquid that mixes well with water. Commercially available solutions with a concentration of 35% and 50% are used. The gradual decomposition of hydrogen peroxide into water and oxygen is accelerated by the effects of heat, light and dust, as well as heavy metal compounds and organic substances. The solution must therefore be stored free from these influences. In the retail industry, disinfectants containing hydrogen peroxide solutions are commercially available under various trade names.

Commercially available hydrogen peroxide solutions are only used in diluted form for disinfection. They should not be used on the construction site in a concentration above 5%. Concentrations of 150 mg/l of water and standing times of 24 hours have proven to be effective for newly laid pipes. In contrast to solutions containing chlorine, hydrogen peroxide can also be discharged into the sewage system at these concentrations. After-treatment prior to discharge is generally not necessary.

Potassium permanganate ($KMnO_4$)
Potassium permanganate is available in the form of violet crystals, and therefore has a practically unlimited shelf life. Solubility in water is very temperature-dependent (28 g/l of water at 0 °C, 91 g/l of water at 30 °C).

Depending on the concentration, the solution has the following colours: Deep violet for strong solutions, reddish violet for medium-strength solutions, pink for diluted solutions. Disinfection with potassium permanganate has become increasingly popular in recent years due to the ease of treatment and disposal. Disinfection with potassium permanganate solution should be performed in the same way as disinfection with chlorine. Solutions with a concentration of 3 to 4% are used here. The application concentration should be around 10 mg of potassium permanganat e/l of water. Potassium permanganate solutions can be completely reduced by adding ascorbic acid (vitamin C). This can be detected by a colour change from violet to colourless.

Chlorine dioxide (ClO_2)
Chlorine dioxide is a gas that dissolves easily in water, and is produced from the two individual components of sodium chlorite solution and sodium peroxide sulphate. The manufacturer's instructions must be observed when handling the ready-to-use solution. The container for the concentrated chlorine dioxide dosing solution (0.3% by weight) must be designed in such a way that no chlorine dioxide gas can escape.

Chemical properties:
The individual components for chlorine dioxide production can easily be stored in sealed containers almost indefinitely. Chlorine dioxide is produced by combining component 1 and component 2. When exposed to light and heat, chlorine dioxide decomposes into ionic end products. The fully prepared product should therefore be stored in a dark and cool place. Under these conditions, an aqueous, 0.3% and pH-neutral chlorine dioxide solution can be kept for approx. 40 days at 22 °C.

Dosing solution:
Aqueous solution with 0.3% or 3 g/l of ClO_2; it is added to the water to achieve the desired disinfectant concentration.

Disposal:
When disinfecting water distribution systems, the excess chlorine dioxide and chlorite, which are among the reaction end products, must be inactivated before being discharged into the sewage system or into open receiving water courses. (E.g. with calcium sulphite filters or activated carbon filters).

Disinfection procedure
Standing procedure
In this procedure, the solution is disinfected by leaving it to stand in the pipe for a prolonged period (not less than 12 hours). It is important to ensure here that the disinfectant solution is added to the water in a constant ratio. The addition may only be completed when the entire pipe has been filled with the disinfectant solution.

Of course, no disinfectant solution must enter the pipe network when in operation. Gate valves and hydrants should be operated during the standing time, so as to disinfect them as well. In the case of very stubborn contamination, subsequent disinfection is necessary. The concentration of the disinfectant solution may increase here. A second flushing with a sufficient amount of water at a high flow velocity is absolutely necessary.

Disinfection is repeated until perfect microbiological findings are available from the samples. When using sodium hypochlorite, chlorine must still be detectable in the water after the standing time.

Flow procedure
For pipes with large nominal sizes, it may be advantageous to flush and disinfect simultaneously over a longer period of time. The concentration of the disinfectant in the water flowing out must be checked several times during the flushing process. It is necessary to replace the pipe contents two to three times.

Disinfection during the pressure test
The combination of disinfection and pressure testing of a pipe has proven to be very effective. Water with disinfectant already mixed in is used here for the pressure test. The high pressure presses the disinfectant solution into the pores of the cement mortar lining. In this procedure, it is essential to separate the pipe to be disinfected from pipes that are in operation.

Disinfection measures for work on existing pipes
In the case of repairs and subsequent integration, a network section often has to be put back into operation very quickly for compelling reasons, meaning that disinfection cannot be carried out according to the procedures described above. Other measures must then be taken to ensure that the drinking water pipe is in a hygienically faultless condition after the work has been completed. This means that parts that have already been cleaned with clean water or disinfectant solution can be installed. After completion of the work, the pipe must be flushed with water at a correspondingly high flow velocity.

If additional disinfection of the pipe is required, it must be ensured that no disinfectant solution gets into the connected system components. The pipe may only be put back into operation after thorough flushing.

Disposal

Disinfectant solutions must be disposed of without harming the environment.
The relevant standards and worksheets must always be observed. DVGW worksheet W 291 and the German Drinking Water Ordinance should be emphasised in particular. In addition, the product-specific information from the manufacturers of disinfectants, the safety data sheets and the accident prevention regulations must be observed.

Microbiological control and approval

After the disinfection of pipes, i.e. after flushing has been completed, water samples must be taken from the pipe for microbiological tests. This is done at the end of the pipe, as well as on sub-parts in the case of longer pipes. When taking samples, the measures specified in the "German standard methods for the examination of water, waste water and sludge" standard must always be taken into account. This includes draining, cleaning and flaming the extraction valves.

According to the existing guidelines, disinfection is considered successful if the microbiological water analysis shows that the colony count does not exceed the guide value of 100 per ml of water. The water must not contain any Escherichia coli (E. coli) or coliform germs. If one of these requirements cannot be met, then the pipe must be disinfected again. The drinking water pipe can only be approved once microbiological harmlessness has been proven on the basis of corresponding examination results. The guidelines of the German Drinking Water Ordinance must be observed for all examinations.

Disinfection process

In summary, the following process steps must be observed when disinfecting drinking water pipes (see also DVGW worksheet W 291):

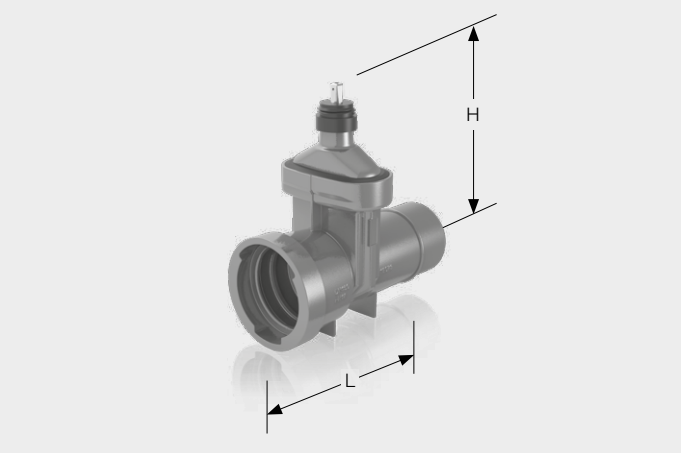
- Flush the pipe
- Disinfect the pipe
- Drain the disinfectant solution after an appropriate standing time, and neutralise if necessary
- Flush the pipe
- Sampling and microbiological examination

The integrated pipe may only be put into operation after impeccable results have been submitted. With regard to the important function of disinfecting drinking water pipes, the work process described above must be followed exactly.

VALVES AND FITTINGS

Gate valves and hydrants

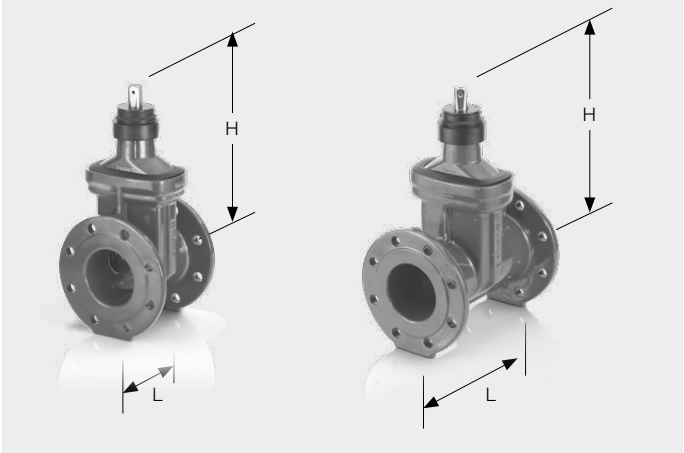
10.1 BLS valves and fittings
Stop valve VS5000, screwless/PN 10/PN 16
according to EN 1171, EN 1074,
installation length – company standard



DN	Deflection capability [°]	Length [mm]	Height [mm]
80	5	405	300
100	5	417	330
125	5	443	370
150	5	499	408
200	4	535	530

Inside and outside epoxy powder coating in accordance with GSK
Inside and outside enamelling in accordance with EN 11 177

10.2 Flange valves and fittings
Stop valve VS5000 series GR 14, GR 15, PN 10/16
According to EN 1171, EN 1074,
installation length according to EN 558



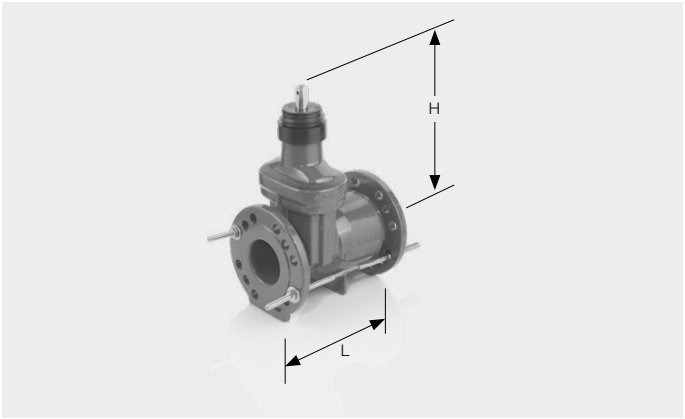
DN	L (GR14) [mm]	L (GR15) [mm]	Height [mm]
40	140	240	202.0
50	150	250	210.5
65	170	270	278.0
80	180	280	297.0
100	190	300	328.0
125	200	325	363.5
150	210	350	411.5
200	230	400	529.5
250	250	450	626.0
300	270	500	698.0
350	290	550	820.0
400	310	600	1000.0

Up to DN 200 for the cover and housing without screw connection.
Up to DN 300 with screw adapter for pinless connection of VONROLL installation sets
DN 500 and DN 600 on request

Inside and outside epoxy powder coating in accordance with GSK
Inside and outside enamelling in accordance with EN 11 177

10.2 Flange valves and fittings
Adjustable-length gate valve VS5000 series
GR 14, GR 15, PN 10/16

According to EN 1171, EN 1074, installation length – company standard

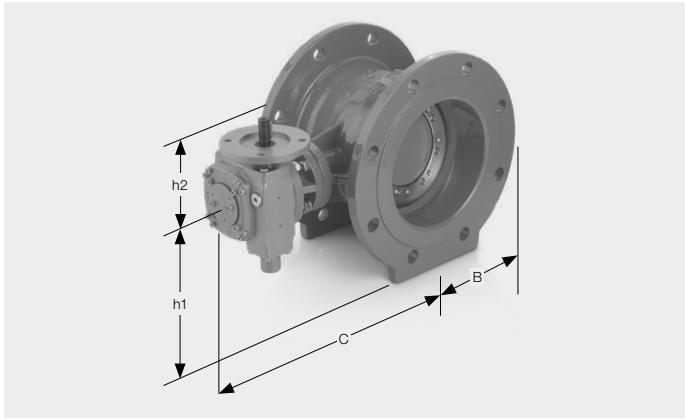


DN	Length [mm]	Height [mm]
80	280 -20/+10	297.0
100	300 -20/+10	328.0
125	325 -20/+10	363.5
150	350 -20/+10	411.5
200	400 -20/+10	529.5
250	450 -20/+10	626.0
300	500 -20/+11	698.0

Inside and outside epoxy powder coating in accordance with GSK
Up to DN 200 for the cover and housing without screw connection
Up to DN 300 with screw adapter for pinless connection of VONROLL installation sets

10.2 Flange valves and fittings
VS5000 butterfly valves, soft-sealing, PN 10/16

With double-eccentrically-mounted valve disc according to EN 593, installation length GR 14 according to EN 558



DN	Install. length L [mm]	PN 10 B [mm]	C [mm]	h1 [mm]	h2 [mm]	Weight [kg]	PN 16 B [mm]	C [mm]	h1 [mm]	h2 [mm]	Weight [kg]
150	210	–	–	–	–	–	152	305	142	151	40
200	230	180	320	170	145	55	180	320	170	145	55
250	250	210	378	200	183	95	210	378	200	183	95
300	270	235	425	230	186	125	235	425	230	195	125
350	290	270	453	255	186	145	270	453	260	195	150
400	310	295	538	285	195	195	295	538	290	325	200
450	330	340	540	310	195	230	340	540	320	325	240
500	350	365	565	335	195	265	385	623	360	325	310
600	390	430	665	390	325	360	475	655	420	330	410
700	430	530	690	450	330	585	530	690	455	330	635
800	470	585	745	510	330	738	585	745	515	330	850
900	510	665	860	560	400	995	665	860	565	400	1100
1000	550	715	910	620	400	1285	715	965	630	485	1685
1200	630	865	1115	730	485	2120	865	1155	745	550	2560
1400	710	965	1255	840	550	2850	965	1282	845	746	3350

Other pressure levels on request

Inside and outside epoxy powder coating in accordance with GSK
Optionally with enamelling according to EN 11 177

10.2 Domestic mains gate valve
According to EN 1074

DN	Installation length [mm]	Weight [kg]
20 (¾")	110	3.5
25 (1")	110	3.5
32 (1 ¼")	110	3.5
40 (1 ½")	120	4.0
50 (2")	140	5.0

10.4 Valve tapping saddle
For cast-iron, steel and asbestos-cement pipe

DN	Threaded outlet	Max. hole size [mm]	Auxiliary valve	Weight [kg]
65 – 400	1 ½"	31	Union	5.0
66 – 400	1 ½"	31	Bale	5.0
67 – 400	2"	45	Ball	5.5
68 – 400	2"	36	Ball	5.5

A bracket corresponding to the pipe type and external diameter is required.

10.4 Valve tapping saddle with integrated auxiliary valve
For cast-iron, steel and asbestos-cement pipe

DN	Threaded outlet	Max. hole size [mm]	Auxiliary valve	Weight [kg]
65 – 400	1 ½"	31	Integrated	5.5

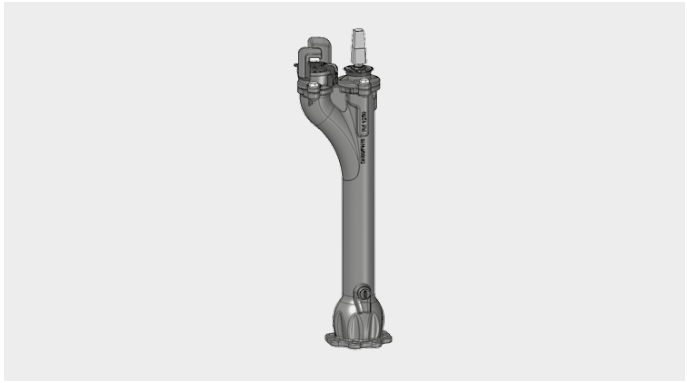
A bracket corresponding to the pipe type and external diameter is required.

10.4 Screw-down interchangeable and adjustable-length pipe coupling PN 10 and PN 16
Flanges in accordance with EN 1092-2

DN	Medium installation length [mm]		Weight [kg]		Adjustment range +/- [mm]
	PN 10	PN 16	PN 10	PN 16	
80	200	200	16	16	25
100	200	200	20	20	
125	200	200	25	25	
150	200	200	34	34	
200	220	220	48	48	
250	220	230	65	74	
300	220	250	72	92	
350	230	260	94	126	
400	230	270	122	162	
450	250	270	140	190	
500	260	280	162	240	
600	260	300	205	330	
700	260	300	256	366	
800	290	320	352	482	
900	290	320	405	546	
1000	290	340	484	715	

Steel, epoxy powder coating or stainless steel

10.3 Hydrant
Underground hydrant UFO DN 80 PN 16
According to EN 14 384, EN 1074-6



Pipe cover [m]	Installation height [mm]	Weight [kg]
0.75	527	23
1.00	722	26
1.25	972	30
1.50	1222	35

Inside and outside epoxy powder coating in accordance with GSK, form A1 and AD1
Inside and outside enamelling in accordance with EN 11 177, form A1 and AD1
With ANIWAH pressure shock reduction when closing the hydrant and metal end stops, as well as EASY – a simple replacement system

10.3 Hydrant
HYTEC PN 16 above-ground hydrant
According to EN 14 384, EN 1074-6

DN	Pipe cover [m]	Installation height [mm]	Weight [kg]
80	1.00	1581	64
80	1.25	1831	68
80	1.50	2130	77
100	1.00	1761	89
100	1.25	1961	96
100	1.50	2261	106

Form AU (single shut-off)
Form AUD (dual shut-off and traffic breakaway design)
Infinitely adjustable through 360°

10.3 Hydrant
Tunnel hydrant HYTEC PN16
According to EN 14 384, EN 1074-6

DN	Pipe cover [m]	Installation height [mm]	Weight [kg]
80	1.00	1581 plus gearbox	64
80	1.25	1831 plus gearbox	68
80	1.50	2130 plus gearbox	77
100	1.00	1761 plus gearbox	89
100	1.25	1961 plus gearbox	96
100	1.50	2261 plus gearbox	106

Form AU (single shut-off)
Form AUD (dual shut-off and traffic breakaway design)
Infinitely adjustable through 360°

10.3 Hydrant
KEULA above-ground hydrant PN16
According to EN 14 384, EN 1074-6

DN	Pipe cover [m]	Installation height [mm]	Weight [kg]
80	0.80	1865	59
80	1.00	2065	64
80	1.25	2315	69
80	1.50	2565	74
100	0.75	1880	72
100	1.00	2080	77
100	1.25	2330	82
100	1.50	2580	87

Round or square
Without A outlet
Form AU (single shut-off)
Form AUD (dual shut-off and traffic breakaway design)
Infinitely adjustable through 360°

10.3 Hydrant
KEULA old town hydrant PN16
According to EN 14 384, EN 1074-6

DN	Pipe cover [m]	Installation height [mm]	Weight [kg]
80	0.80	1865	73
80	1.00	2065	78
80	1.25	2315	83
80	1.50	2565	88
100	0.75	1880	83
100	1.00	2080	88
100	1.25	2330	93
100	1.50	2580	98

Form AU (single shut-off)
Form AUD (dual shut-off and traffic breakaway design)
Infinitely adjustable through 360°

10.3 Hydrant
KEULA above-ground hydrants with drop jacket PN16
According to EN 14 384, EN 1074-6

DN	Pipe cover [m]	Installation height [mm]	Weight [kg]
100	1.00	2100	110
100	1.25	2350	115
100	1.50	2600	120

Form AFU (single shut-off with drop jacket)
Form AFUD
(dual shut-off with drop jacket and traffic breakaway design)
Infinitely adjustable through 360°

11

STANDARDS AND GUIDELINES

EN standards

EN 545 Ductile iron pipes, fittings, accessories and their joints for water pipelines – Requirements and test methods

EN 681-1 Elastomeric seals – Material requirements for pipe joint seals used in water and drainage applications
Part 1: Vulcanized rubber

EN 805 Water supply – Requirements for systems and components outside buildings

EN 1092-1 Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories
Part 1: Steel flanges, PN designated

EN 1092-2 Flanges and their joints – Circular flanges for pipes, valves, fittings/accessories, PN designated
Part 2: Cast iron flanges

EN 1295-1 Structural design of buried pipelines under various conditions of loading
Part 1: General requirements

EN 1333 Flanges and their joints – Pipework components – Definition and selection of PN

EN 1514-1 Flanges and their joints – Dimensions of gaskets for PN-designated flanges
Part 1: Non-metallic flat gaskets with or without inserts

EN 1515-1 Flanges and their joints – Bolting
Part 1: Selection of bolting

EN 1563 Founding – Spheroidal graphite cast irons

EN 10 204 Metallic products – Types of inspection documents

EN 10 298 Steel tubes and fittings for onshore and offshore pipelines – Internal lining with cement mortar

EN 12 502-1 Protection of metallic materials against corrosion – Guidance on the assessment of corrosion likelihood in water distribution and storage systems

EN 12 502-3 Protection of metallic materials against corrosion – Guidance on the assessment of corrosion likelihood in water distribution and storage systems
Part 3: Influencing factors for hot dip galvanised ferrous materials

EN 12 502-4 Protection of metallic materials against corrosion – Guidance on the assessment of corrosion likelihood in water distribution and storage systems
Part 4: Influencing factors for stainless steels

EN 12 502-5 Protection of metallic materials against corrosion – Guidance on the assessment of corrosion likelihood in water distribution and storage systems
Part 5: Influencing factors for cast iron, unalloyed and low alloyed steels

EN 12 502-2 Protection of metallic materials against corrosion – Guidance on the assessment of corrosion likelihood in water distribution and storage systems
Part 2: Influencing factors for copper and copper alloys

EN 15 655-1
External polyurethane coating for pipes. Requirements and test methods.

EN ISO standards

EN 13 052-1
Influence of organic materials on water intended for human consumption – Determination of odour and flavour assessment of water in piping systems
Part 1: Test method

EN 14 628
Ductile iron pipes, fittings and accessories – Requirements and test methods – Part 1: PE coatings

EN 14 801
Conditions for the classification of products for pipe systems for water supply and wastewater disposal according to the pressures that occur

EN 14 901
Ductile iron pipes, fittings and accessories – Requirements and test methods for organic coatings of ductile iron fittings and accessories – Part 1: Epoxy coating (heavy duty)

EN 15 189
External polyurethane coating for pipes. Requirements and test methods.

EN 15 542
Ductile iron pipes, fittings and accessories – External cement mortar coating for pipes – Requirements and test methods

EN ISO 1071
Welding consumables – Covered electrodes, wires, rods and tubular cored electrodes for fusion welding of cast iron – Classification

EN ISO 9001
Quality management systems – Requirements

EN ISO 7091
Plain washers – Normal series – Product grade C

EN ISO 4034
Hexagon regular nuts (style 1) – Product grade C

EN ISO 4016
Hexagon head bolts – Product grade C

DIN standards

DIN 1054
Subsoil – Verification of the safety of earthworks and foundations

DIN 1055-2
Actions on structures –
Part 2: Soil properties

DIN 1960
German construction contract procedures (VOB) – Part A:
General provisions relating to the award of construction contracts

DIN 1998
Placement of service conduits in public circulation areas; Guideline for planning

DIN 2000
Central drinking water supply – Guidelines regarding requirements for drinking water, planning, construction, operation and maintenance of supply plants – Technical rule of the DVGW

DIN 2403
Identification of pipelines according to the fluid conveyed

DIN 2429-1
Graphical symbols for technical drawings; Pipes; General

DIN 2429-2
Graphical symbols for technical drawings; Pipes; Symbolic representation

DIN 2880
Application of cement mortar lining for cast iron pipes, steel pipes and fittings

DIN 3475
Cast iron valves and fittings with spheroidal graphite for untreated and drinking water; Protection against corrosion by inside enamelling; General quality requirements, testing

DIN 4046
Water supply; Terms;
Technical rule of the DVGW

DIN 4124
Excavations and trenches –
Slopes, planking and strutting breadths of working spaces

DIN 18 196
Earthworks and foundations – Soil classification for civil engineering purposes

DIN 18 299
German construction contract procedures (VOB) – Part C: General technical specifications in construction contracts (ATV); General rules for construction work of any kind

DIN standards

DIN 18 300
German construction contract procedures (VOB) – Part C: General technical specifications in construction contracts (ATV); Earthworks

DIN 18 920
Vegetation technology in landscaping – Protection of trees, plantations and vegetation areas during construction work

DIN 28 601
Ductile iron pipes and fittings – Screwed socket joints – Assembly, sockets, screw rings, sealing rings and slip rings

DIN 28 602
Ductile iron pipes and fittings – Bolted gland joints – Assembly, sockets, counter ring, sealing ring, bolts and nuts

DIN 28 603
Ductile iron pipes and fittings – Push-in joints – Survey, sockets and gaskets

DIN 28 650
Ductile iron fittings – Double socket 30° bends, EN-fittings, MI-fittings, IT-fittings – Application, dimensions

DIN 30 672
External organic coatings for the corrosion protection of buried or immersed pipelines for continuous operating temperatures up to 50 °C without cathodic protection – Tapes and shrinkable materials

DIN 30 674-3
Sheathing ductile cast iron pipes – Part 3: Zinc coating with protective sheathing

DIN 30 674-5
External protection of ductile cast iron pipes; polyethylene sleeving

DIN 30 675-2
External corrosion protection of buried pipes; Corrosion protection systems and application for ductile iron pipes

DIN 50 900-2
Corrosion of metals – Terms – Part 2: Electrochemical terms

DIN 50 929-1
Corrosion of metals; Probability of corrosion of metallic materials when subject to corrosion from the outside; General

DIN 50 929-3
Corrosion of metals; Probability of corrosion of metallic materials when subject to corrosion from the outside; Buried and underwater pipelines and structural components

DVGW (water)

W 101
Guidelines for drinking water protection areas; Part 1: Groundwater protection areas

W 102
Guidelines for drinking water protection areas; Part 2: Reservoir protection areas – Worksheet

KTW-BWGL
Assessment basis for plastics and other organic materials in contact with drinking water.

W 291
Cleaning and disinfection of water distribution systems

W 303
Dynamic pressure variations in water supply systems

W 333
Tapping valves and tapping operation in water supply – Data sheet

W 339
Specialist in socket technology for metal pipe systems; Teaching and testing instructions – Worksheet

W 346
Cast iron and steel pipe parts with cement mortar lining, handling

W 347
Hygienic requirements for cementitious materials in the drinking water sector – Testing and rating

W 348
Requirements of bitumen coatings on ductile cast iron fittings and in the connection area of pipes made of ductile cast iron, unalloyed and low alloyed steel

W 400-1
Draft of technical rules for water supply systems; Part 1: Design

W 400-2
Technical rules for water supply systems, Part 2: Construction and testing

GW 9
Assessment of soils with regard to their corrosion behaviour on buried pipelines and containers made of unalloyed and low alloyed ferrous materials

GW 14
Repairing defects in corrosion protection coatings on pipes and pipeline components made of ferrous materials

GW 15
Recoating of pipes, valves and fittings; Training and test plan

GW 301
Qualification criteria for pipework construction companies

GW 303-1
Calculation of gas and water pipe networks Part 1: Hydraulic principles, network modelling and calculation

GW 304
Pipe jacking and related techniques

GW 310
Concrete abutments – Design principles

GW 312
Static calculation of jacking pipes

GW 315
Protection of supply systems during construction works

GW 316
Locating buried pipes and access covers

GW 321
Controllable horizontal directional drilling methods for gas and water pipelines – Requirements, quality and testing

GW 322-1
No-dig replacement of gas and water pipework – Part 1: Using pushing or pulling procedures – Requirements, quality and testing

GW 323
No-dig replacement of gas and water supply lines by means of burst lining; Requirements, quality and testing

GW 329
Specialist supervision and specialist personnel for controllable horizontal directional drilling methods; Teaching and testing instructions – Worksheet – Data sheet

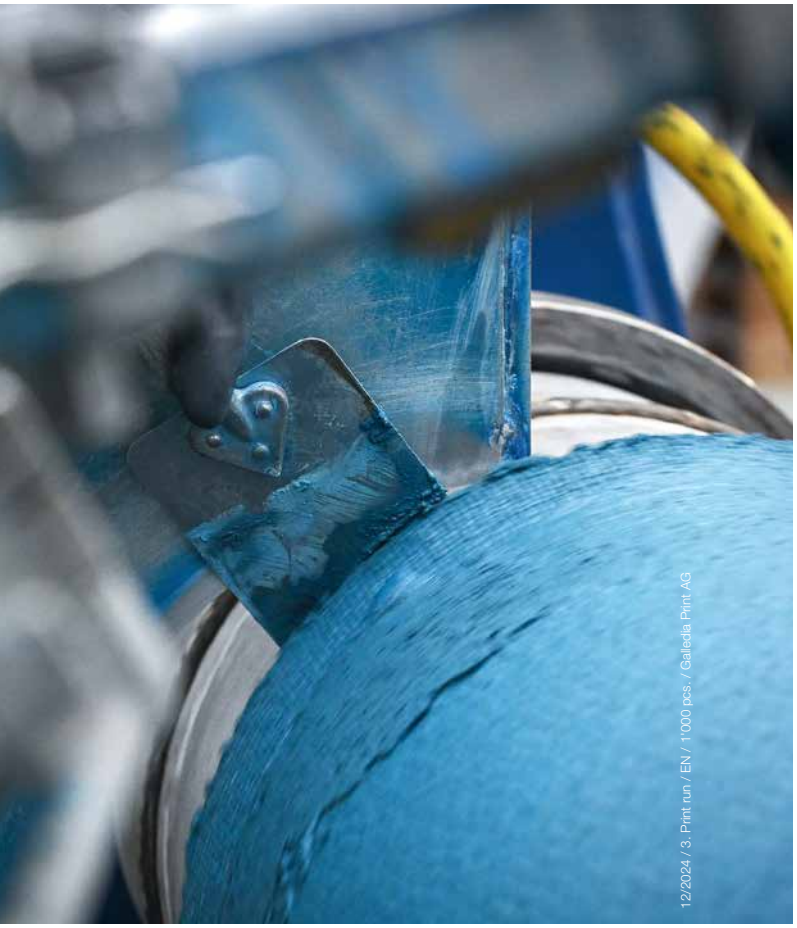
GW 337
Ductile iron pipes, fittings and accessories for gas and water supply – Requirements and tests

GW 368
Restrained socket joints for ductile iron and steel pipes, fittings and valves

DVGW VP standards

VP 546
Seals for socket joints in ductile iron or steel pipelines – Requirements and tests

VP 547
Seals for flange joints in ductile iron pipelines – Requirements and tests



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