10 HANDLING PIPE CONSTRUCTION

10.1 Delivery

10.2 Pipe Construction - Buried Laying

10.3 Pipe Construction - Overground Work

10.4 Check List for Pipe Construction

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10.1.1 Transport / Unloading / Storage

Transport

isoplus-pipes and components as well as accessories will be delivered by truck to building site respectively to the material storage. The traffic route has to be suitable for heavy-load-traffic as well as for trucks with 12 m respectively 16 m loading area.

Before delivery the pipe ends will be closed with yellow caps for protection reasons. These protection caps should remain on the pipe ends until the assembling. Also in case of unloading of the **isoplus**-pipes, the caps may not be removed. Additionally it should be considered that the pipes will be loaded longitudinal and even.

The loading area of the trucks has to be checked concerning any rigid- and bearing out parts. If necessary such parts have to be removed in order to avoid damages of the pipes and especially of the PEHD-jacket pipe.

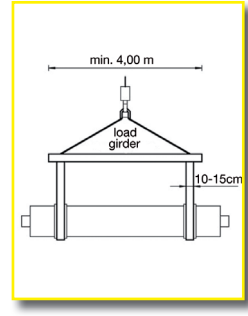
All couplers and shrinkable material as well as all accessories like end caps, sealing rings etc. will be delivered in protecting envelopes or/and cardboards. Also these cardboards may not be removed or damaged before beginning of the assembling works.

Unloading

Unloading of trucks will be carried out by the pipe layer or by third parties. During this the safety regulations of all relevant regulations for preventing of accidents have to be considered. All **isoplus**-pipes, components and accessories have to be unloaded correctly and material-friendly, and may not thrown from the loading area.

At arrival of the material it has to be checked concerning any external damages. The completeness of the delivery has to be checked and recorded. Any damages have to be marked resp. registered clearly on the delivery papers.

Smaller dimensions and accessories should be preferable unload manually. In case of bigger dimensions the unloading will be carried out by use of a crane which should be provided. For that two textile- or nylon belts 10-15 cm wide, with a load-beam of at least 4 m length or a truck with reacher should be used, for 12 m and 16 m pipe bars generally.



Because of this a not admissible bending and damage of the pipes, as well as a possible break of integrated systems, like leak detecting wires will be avoided.

Pulling and rolling on the ground as well as the use of steel ropes or chains is not permitted. Rough and uneven ground will cause scrapes and pressure marks at the jacket-pipe.

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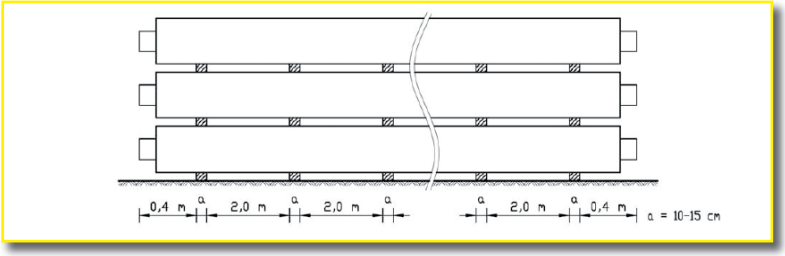
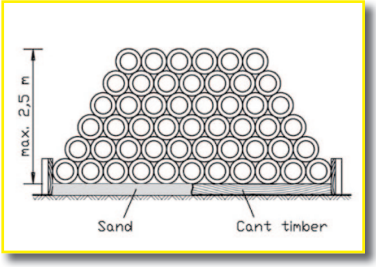
Storage

isoplus-pipe bars and components have to be stored on stone-free and dry areas, separated by dimensions. Water stemming soils and groundwater endangered soils should be avoided. Sand sacks or timber-squares will be used as support for the pipe bars. Depending from dimension these should be between 10 and 15 cm wide and should be placed in a distance of approx. 2,00 m each. Crown pressure at jacket should not exceed 40 N/cm^2 respectively 4 kg/cm^2.

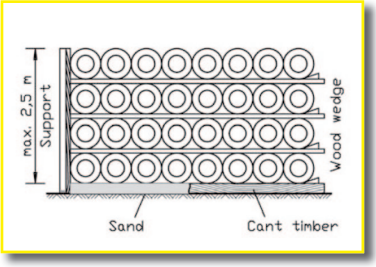


For safety reasons the height of pile should be limited to maximum 2,50 m. Conical or squared pipe-piles may be used. The pipes have to be generally protected against lateral slipping, by use of supports, pegs or wooden wedges.

Conical form



Cuboid form



In case that the storage should last for a longer period, corresponding protection measures against all kind of weather conditions have to be provided. During a frost period the **isoplus**-pipes, -components and -accessories have to be protected against inexpert handling like stroke- and shock effect, bending etc.

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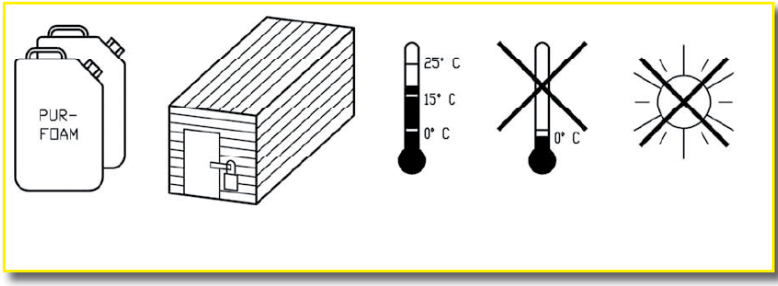
Accessories and incidentals like couplers, shrinkable sleeves, end caps, expansion pads etc. have to be as well stored sorted, dry, frost-protected and protected from direct sun-rays. The PUR-local foam components have, the already mentioned accessories should be stored in a closed room or container with anti-theft device, at a temperature between + 15° C and + 25° C.



The PUR-local foam will be delivered separated in component A, Polyol - bright, and component B, Isocyanat - dark, in 1 l, 5 l or 10 l cans. These cans may be opened just before using it. At temperatures below 0 °C the PUR-foam will crystallize. Frozen respectively crystallized foam may not be used for post insulation.

For the correct storage of all **isoplus**-system components the pipe-layer, respectively a third party will be exclusively responsible. He has to confirm the completeness of material and to supervise the material distribution during the construction period. The assembling material which will be required for post insulation has to be given to the AGFW-/BFW-approved **isoplus**-factory-engineers at the execution term.

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10.1.2 Special Features Flexible Compound Systems

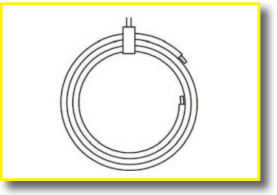
Transport

isoplus-flexible pipes will be delivered in coils (Diameter ≥ 2,00 m) per truck to the building site respectively to the material stock. In order to protect the carrier pipe the pipe ends are closed with yellow caps, which should be removed not before the connection of the pipes.

In case of a further transportation of the pipes the loading area of the truck should be checked concerning rigid stick out parts. The pipes should lay plain and symmetrically on the loading area.

Unloading

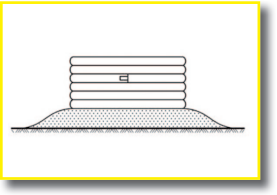
Unloading will be made properly and carefully by the pipe-layer or third parties. In case of unloading by use of a crane, belt with a width of at least 10 cm should be used. Fork-ends of fork-lifts have to be covered with protecting pipes.



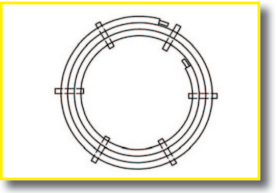
Pulling and rolling of flexible pipes on the ground as well as the use of steel ropes or chains is not allowed because of scratches and pressure-spots at the jacket-pipe, caused by uneven grounds.

Storage

Flexible pipes have to be stored on even and dry surfaces, free of stones. Ground water endangered and water stowed soils should be avoid. Sand banks respectively -sacks or squared timber in star-constellation may be used as support.



In case that the pipes will be stored for a longer time, suitable protection measures against all weather conditions have to be provided. During a period of frost the jacket-pipe as well as the **isoplus** carrier pipe and the **isopex** carrier pipe has to be protected against strikes and shocks.



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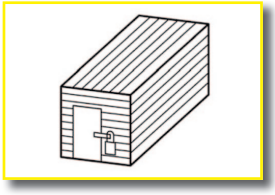
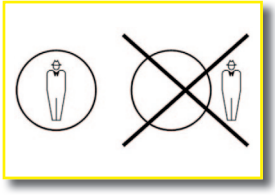
Accessories for flexible pipes have to be stored within a lockable room or container. The pipe-layer respectively a third party will be exclusively responsible for the correct storage of all system components. He will confirm the receipt of the complete material and will control the distribution of the material during the construction period.



Cut Off

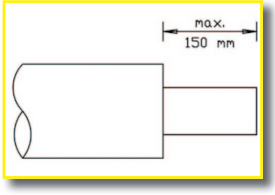
Flexible pipe-coils have to be opened from inside, due to the remaining tension.



ATTENTION: Danger of injuring !

For assembling the **isoplus**-flexible pipes will be uncoiled and cutted to the corresponding lengths. The coils should be also turned accordingly. Additionally it should be considered, that the coil will be not pulled on an uneven respectively stone containing ground.

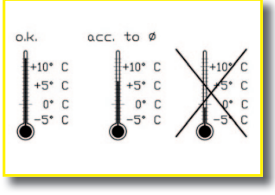
After the right-angled cutting of the flexible pipe, the jacket-pipe and the PUR-foam should be cutted in a distance of max. 150 mm from the cut. Then the jacket will be peeled by use of a suitable tool and the foam, as well as the remaining foam will be removed.



ATTENTION: The red E/VAL-diffusion barrier of the **isopex**-pipe, 6 bar - heating, may be not destroyed!

Processing

Pipe laying and processing of **isoplus**-flexible pipes will be generally possible up to an outside temperature of +10 °C. At temperatures below 10 °C eventually suitable precautions should be provided, depending from dimensions. Up to PELD jacket-pipe dimension of 90 mm the assembling of flexible pipes will be also possible at ≥ 0 °C.



In case of lower temperatures PUR-foam and jacket pipes can break. The risk will generally exist in case of jacket pipes > 90 mm and in case of **isopex**-double pipes at temperatures below 10 °C.

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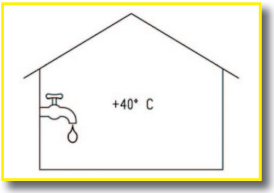
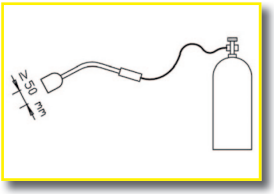
In case that **isoplus**-flexible pipes should nevertheless laid at such low outside temperatures the suitable processing temperature has to be reached by storing the pipes inside of a heated room or by filling them with warm water and/or by heat supply (max. 40 °C on to the PELD-jacket) by use of a suitable equipment. Water filled pipes may not be stored during a longer period of frost.



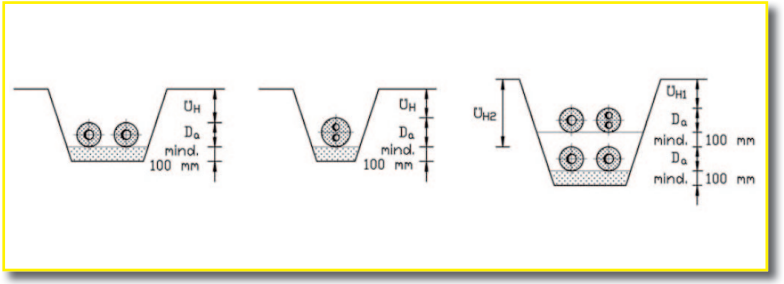
In case that the pre-heating will be carried out by use of a gas-burner, a burner-head of minimum Ø 50 mm has to be used. Preheating should be made with yellow flame in pendulum movements over a longer distance. Selective heating of the jacket-pipe will lead to damages of the flexible compound system.



Pipe-Laying

Assembling of flexible pipes will be normally on a 10 cm sand bed. Eventually required manholes should be provided as working area. Due to the long delivery lengths this requirement will occur only exceptionally. Supports have to be provided in a distance of 2,00 m.

Flexible pipes may be laid side by side or on top of each other into the trenches. Pipe-laying by use of a special horizontal flush-drilling procedure will be also possible. The instruction of the executing company has to be strictly considered.



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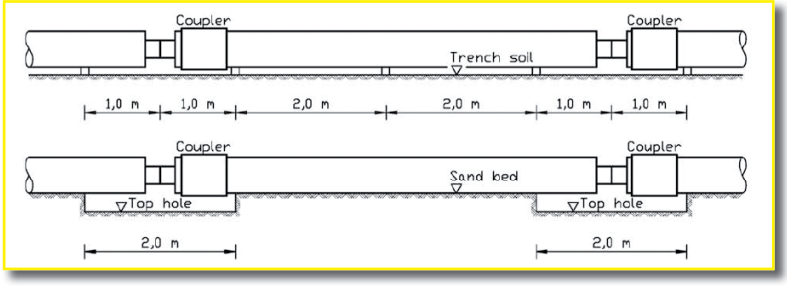
10.2.1 Assembling Supports / Top-Holes / Foreign Lines

Assembling Supports / Top-Holes

The assembling of the pipeline will be made on timber squares, hard-foam bars, sand sacks or directly on a 15 cm sand layer. In case of direct laying on a sand bed top-holes will be required as working space at the connection points. Supports will be placed in a distance of 2 m that means in case of 6 m pipe bars three and in case of 12 m pipe bars six supports will be necessary. In order to reach a correct coupler assembling, the first support should be placed at least 1 m from the pipe end respectively from the weld seam.



If squared timber will be used, these have to be removed before the sand filling of the trench. This will avoid not admissible pressure loads on the PEHD-jacket-pipe. Sand sacks have to be slit before refilling.

Foreign Lines

Essential hindrance concerning the line guidance have to be considered in case of district heating lines which will be constructed for the public traffic, due to existing lines and facilities like i. e. for gas, water, sewage, electricity or post. Therefore the location of these obstacles has to be clarified with the corresponding authorities by means of estate layouts and sectional drawings, before the beginning of the construction works. The result has to be determined in written. The following distances have to be meet in accordance with the AGFW, providing that no other local regulations should be valid:

Foreign Line - Type	Minimum Distance	
	at crossing or parallel laying up to 5 m	in case of parallel laying above 5 m
Gas- and water pipelines	20 - 30 cm	40 cm
1 kV - signal- or measure cable	30 cm	30 cm
10 kV cable or a 30 kV cable	60 cm	70 cm
several 30 kV cable or cable of more than 60 kV	100 cm	150 cm

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10.2.2 Connection Technology / Weld-Seam-Test

Connection Technology

Before welding the pipes and components, the appropriate casing joints with the associated shrink joints must be inserted onto the casing pipe next to the weld. If adverse weather conditions are present, a protective tent must be erected over the joint area for preparation and implementation. While welding, the front sides of the pipe ends must be protected from welding sparks and burns using damp cloths, flame-retardant mats, or front covers.

The joints of the black steel pipes can be implemented in accordance with DIN ISO 857-1 using the following procedures: manual bend welding, gas welding with an oxygen-acetylene flame, tungsten inert gas welding (TIG), or a combination of processes. AGFW worksheet FW 446 applies to the quality of the weld, its inspection and its evaluation.

Companies carrying out welding work must meet the welding technical requirements in accordance with EN ISO 3834 and must be certified in accordance with AGFW Worksheet FW 601. Welding work may only be carried out by welders who are in possession of a valid test certificate in accordance with DIN EN 287-1. In addition, the corresponding qualification in accordance with DVGW GW 350 must be documented under construction site conditions.

The welding procedure to be used must be appropriate for construction site welding. DIN 2559-2 and 3 as well as DIN EN ISO 9692-1 based on DIN EN 448 are decisive for weld preparation, the joint form on the steel, and the distance between the pipe ends.

The additional weld materials must be matched to and approved with the basic materials; they must be selected by weld procedure in accordance with DIN EN 12536, DIN EN ISO 2560 or DIN EN ISO 636 and must be clearly marked. The completed welds must meet the requirements of evaluation groups B and C in accordance with DIN EN ISO 5817 in accordance with AGFW Worksheet FW 601; only evaluation group B is required in accordance with DIN EN 489.

Weld-Seam-Test

After the welding works are finished the welding seams have to be tested according to the agreed extent between purchaser and supplier. Obvious damages are classified in DIN EN ISO 17637. After this, the non-destructive weld test must be carried out in an environment to be determined. If a radiographic test is used, test class B of DIN EN 1435 is desirable.

A penetration test must be carried out in accordance with DIN EN 571-1, the ultrasound test in accordance with EN 1714, a magnet particle test in accordance with DIN EN ISO 17638, and an eddy current test in accordance with DIN 54141. After the non-destructive test, the leakage and/or sealtightness test must be carried out in accordance with AGFW Information Sheet FW 602.

The visual inspection method using air is recommended compared with that using water in a control test; during the test the welds are coated with a foaming agent. If no froth bubbles form within at least 1 minute, its state of sealtightness is considered proven. For the method using internal air overpressure the test pressure is 0,2 to 0,5 bar, with external air underpressure (vacuum glasses) an absolute maximum of 0,6 bar.

A cold water pressure test must be carried out on the vented route in accordance with the DVGW Worksheet G 469, Procedure A1. The test pressure is 1,3 x the operating pressure at its highest point and must be maintained for 3 hours.

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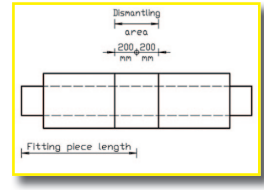
10.2.3 Fitting Pieces

Due to individual pipeline guidance it will be necessary to shorten standard pipe bars into smaller fitting pieces. Due to this any pipe line length can be realised. The following working steps will be necessary for the production of a fitting piece:

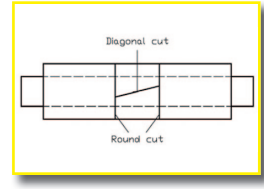
The length of the fitting piece will be measured at a pipe bar and marked. At the left and the right from this mark the 2 • 200 mm wide respectively long area of dismantling will be marked.



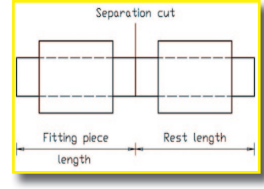
Cut the PEHD-jacket at the marks and connect both round cuts with a diagonal cut.

ATTENTION: At temperatures of < 10 °C the jacket pipe has to be heated before cutting, due to danger of cracks.

ATTENTION: The alarm wires of the monitoring system may not be cut when the round cuts will be made. Thereafter the jacket-pipe has to be lifted off by use of a suitable tool, i. e. mortise chisel.

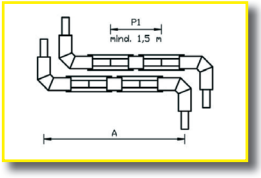


The PUR-foam has to be removed by use of a hammer and a mortise chisel. Thereafter the alarm wires will be cut central. Remaining foam on the steel pipe has to be removed by use of an emery linen. Finally the steel- respectively the carrier pipe has to be cut at the middle of the dismantling area.



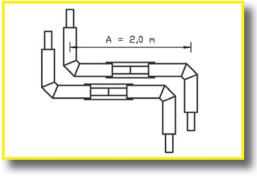
10.2.4 Z-Leaps / U-Elbow / Parallel-Branch

Z-Leaps with Fitting Piece



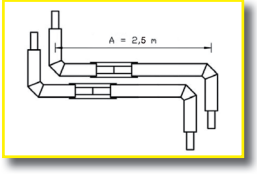
The length of Z-elbow [P1] will be in correspondence with the static requirements. The cross-angle [A] can be seen from the **isoplus**-trench-design. Theses leaps will be assembled with two insulated elbows, normally 90°, and a fitting piece. The fitting piece [P1] should be at least 1,50 m long in order to put the connection couplers on.

Z-Leaps without Fitting Piece up to DN 100



A transverse leg [A] of 2,00 m is usually sufficient from a static point of view in the smaller nominal size range up to DN 100. No fitting piece will be necessary in case that 4 long-elbows 1,0 • 1,0 m will be used. Slipping over on the 1 m long angle of the elbows will be possible.

Z-Leaps without Fitting Piece from DN 125



A transverse leg [A] of 2,50 m is usually sufficient from a static point of view in the medium nominal size range up to DN 125. To achieve this, 2 bend pieces with bars 1,0 • 1,0 m long and 2 bend pieces with bars 1,0 • 1,5 m long must be used. During this process, inserting the joint is also possible on the long bars of the bend.
As of approx. DN 400, detailed static calculations are required.

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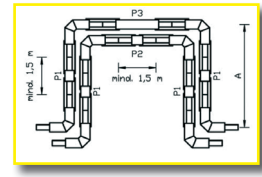
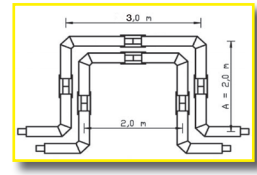
U-Elbow with Fitting Piece

The length of the U-elbow [P1] will be in correspondence with the static requirements. The total bearing out [A] can be seen from the **isoplus**-trench-design. The fitting pieces [P2] + [P3] at U-elbow head are different in length, whereas the inner one [P2] should be at least 1,50 m long. This will allow to put on both couplers.



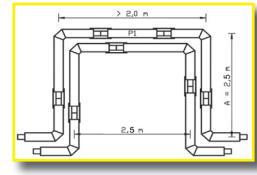
U-Elbow without Fitting Piece up to DN 100

In the smaller nominal size range up to DN 100, from a static point of view, a projection [A] of 2,00 m is usually sufficient. When using 6 bend pieces with leg lengths of 1,0 • 1,0 m and 2 bend pieces with legs 1,0 • 1,5 m long, fitting pieces are not usually required. During this process, inserting the joint is also possible on the long legs of the bend.



U-Elbow with Fitting Piece from DN 125

A projection [A] of 2,50 m is usually sufficient from a static point of view in the medium nominal size range up to DN 125. When using 3 bend pieces with legs 1,0 • 1,0 m long and 5 bend pieces with legs 1,0 • 1,5 m long, only one fitting piece [P1] on the external U-bend head, whose length is determined by the dimension and the pipe distance, is required. During this process, inserting the joint is also possible on the long legs of the bend. Detailed static calculations are required above DN 400.



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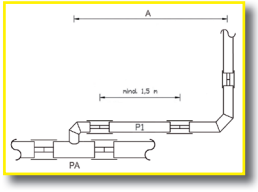
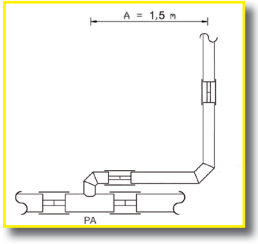
Parallel-Branch with Fitting Piece

In a parallel branch, the length of the fitting piece [P1] is dependent on the static requirements. The transverse leg [A] is given in the **isoplus** route plan. These offsets are assembled from a finished bend, in general 90°, and a fitting piece. The fitting piece [P1] must be at least 1,50 m long in order to insert the casing joints onto it.



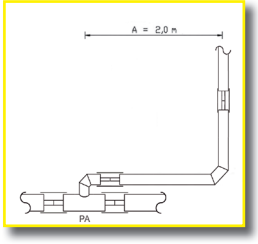
Parallel-Branch without Fitting Piece up to DN 100

A transverse leg [A] of 1,50 m is usually sufficient from a static point of view in the smaller nominal size range up to DN 100. When using bends with legs 1,0 • 1,0 m long, no fitting piece is required. During this process, inserting the joint is also possible on the long legs of the bend.



Parallel-Branch without Fitting Piece from DN 125

A transverse leg [A] 2,00 m long is usually sufficient from a static point of view in the nominal size range from DN 125 to approx. DN 250. When using bends with legs 1,0 • 1,5 m long, no fitting piece is required. During this process, inserting the joint is also possible on the long legs of the bend. possible on the long legs of the bend. Detailed static calculations are required above DN 400.



Edition: 16.01.2012

10.2.5 Shut-Off Valve

Shut-Off Valve

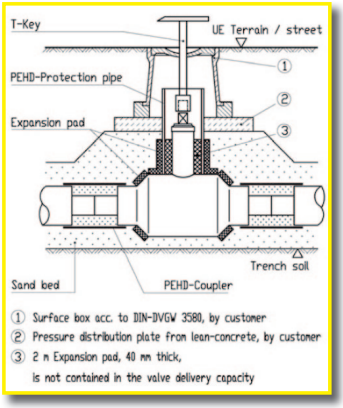
Shut-off valves will be welded into the line like a straight piece of pipe. The welding works have to be carried out in passage-position that means with open ball, in order to avoid a damage of the sealing. Installation within the area of angles of L-, Z- or U-elbows will be not admissible because of occurring bending tensions.

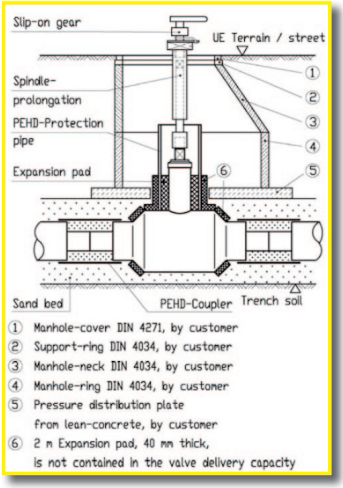
The PEHD-protection pipe, with inside centering support, which is not part of the delivery, will be shortened according to the covering height. It will be put over the operational dome and will end in a street-cap or pit-ring. Operating will be made by use of a T-key or by a portable plug-on-gear, which should be generally used starting from dimension DN 150.

Please consider during installation that there will be enough space for movement, due to possible axial expansion. The prolongation will be put vertical on the conical square of the valve-dome. The prolongation will end also with a conical square, on which now the T-key or/and the plug-on-gear can be put.

After the assembling will be finished, the first closing procedure should be carried out after flushing the pipeline, in order to remove rigid particles in the pipes, which may cause damages of the sealings. The shut-off valves are right hand closing or clockwise up to a 90°- stop, the opening will be contrary. The stops should not be over winded by force. Opening and closing should be carried out slowly, in order to avoid pressure shocks in the pipe system.

In between or adjusted positions are not allowed, due to possible damages of the sealings. The use of not suitable torque moment-duplicators, or inexpert prolongation of the T-key are not allowed and will lead to an exclusion of warranty.





10.2.6 Drain / Vent

Drain / Vent

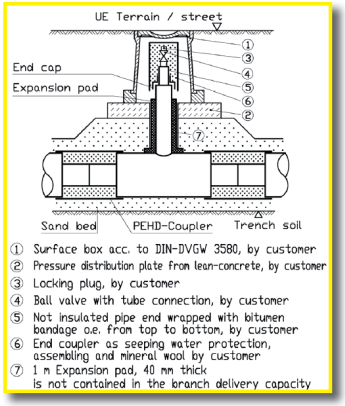
At top and low points, which will especially occur at constant covering heights of pipelines, draining or/ and venting (ELE/ELÜ) have to be provided, according to the regulations of the local management of works. ELE/ELÜ branches with a vertical exit will be welded into the pipeline like a straight piece of pipe, see **chapter 2.2.8.** Installation at the area of L-, or Z- angle or U-elbows will be not allowed, due to occurring of bending tensions.

After adjusting of the exit height an end cap, see **chapter 10.2.12**, has to be assembled. Thereafter the assembling of a draining- respectively venting valve will be carried out at site. At the outside-thread of the ball valve, the suction tube can be connected.

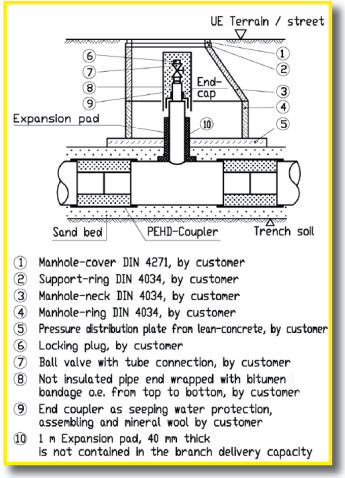
The still visible not insulated steel pipe has to be wrapped with a bitumen bandage. Please consider that the direction of the wrapping should be made from top to bottom. Finally a PEHD-blind-cover will be put over the complete ELE/ELÜ- construction, for protection against percolating water. This blind-cover has to be equipped with a suitable insulation material.

For protection against axial movements expansion pads have to be assembled at the exit, in accordance with the **isoplus**-trench-design. The mentioned end cap, the PEHD-blind-cover and the expansion pads are not part of the delivery range of the ELE- or/and ELÜ-branches.

Alternatively to the vertical-branches also pre-fabricated draining/venting, acc. to **chapter 2.2.9,** can be used. At the exit of these a corresponding ball valve is integrated respectively foamed in. For more information, see the ELE-/ELÜ-ball valve **chapter 2.2.10.**



① Surface box acc. to DIN-DVGW 3580, by customer
② Pressure distribution plate from lean-concrete, by customer
③ Locking plug, by customer
④ Ball valve with tube connection, by customer
⑤ Not insulated pipe end wrapped with bitumen bandage a.e. from top to bottom, by customer
⑥ End coupler as seeping water protection, assembling and mineral wool by customer
⑦ 1 m Expansion pad, 40 mm thick is not contained in the branch delivery capacity



① Manhole-cover DIN 4271, by customer
② Support-ring DIN 4034, by customer
③ Manhole-neck DIN 4034, by customer
④ Manhole-ring DIN 4034, by customer
⑤ Pressure distribution plate from lean-concrete, by customer
⑥ Locking plug, by customer
⑦ Ball valve with tube connection, by customer
⑧ Not insulated pipe end wrapped with bitumen bandage a.e. from top to bottom, by customer
⑨ End coupler as seeping water protection, assembling and mineral wool by customer
⑩ 1 m Expansion pad, 40 mm thick is not contained in the branch delivery capacity

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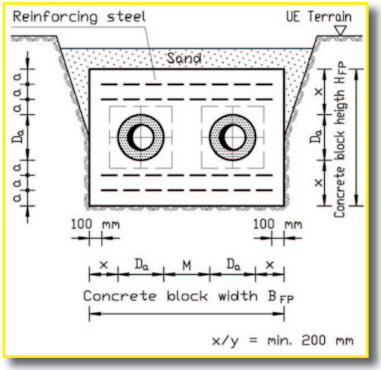
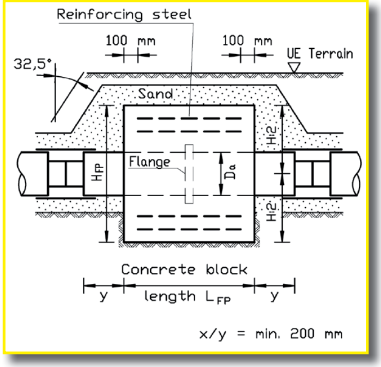
10.2.7 Anchor - Concrete Block

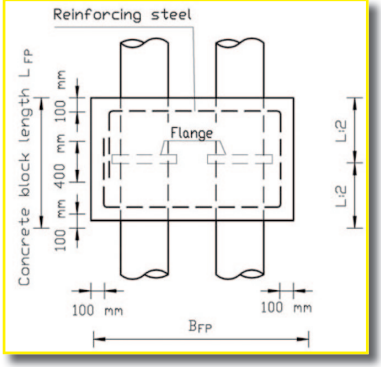
Concrete blocks have to be installed into grown soils. The required excavation has to be made before pipe laying. In case that an anchor will be located before a construction building or a house, a clearance of at least 2,00 m should strictly considered between the brickwork and the anchor. A suitable drainage has to be provided in case that stemming groundwater cannot be excluded at the concrete-block.

The execution of the water tight block has to be made by use of blast furnace cement with concrete quality C 20/25 F2 acc. to DIN 1045-2 and DIN EN 206-1 incl. the required armouring of B500B acc. to DIN 488-1. The irons have to be bended acc. to the standard and can be welded at the overlapping. Before the pipeline will be put into operation the pipe trench and the concrete block has to be filled completely. The binding of the concrete should be totally completed. First after 28 days the given-consistency will be reached. The specific block-size as well as the corresponding reinforcing steel can be seen from **isoplus**-pipeline design, see **chapter 2.2.12**.

Dimension Steel Pipe		Reinforcing Steel	
Norminal Diameter in DN	Outside-Ø d_a in mm	Number resp. piece	Diameter Ø in mm
20	26,9	2	8
25	33,7	2	8
32	42,4	2	8
40	48,3	2	8
50	60,3	2	8
65	76,1	2	8
80	88,9	2	8
100	114,3	4	8
125	139,7	4	8
150	168,3	4	8
200	219,1	6	10
250	273,0	6	10
300	323,9	6	10







10.2.8 Connection Couplers

Several coupler constructions are available for the different technical requirements. All PEHD-connection couplers are used for non-positive gas- and water tight jacket-pipe connections. The assembling information for all kind of couplers have been integrated into the **chapter 6** for simple use and handling of the available **isoplus**-Design Manual.

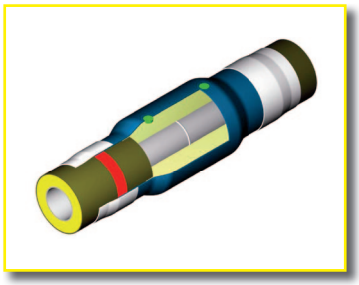
Before welding of the carrier pipes all kind of couplers as well as the shrinkable sleeves should be slipped over pipe bars. Only the pipe-layer or a qualified third party will be responsible for that.

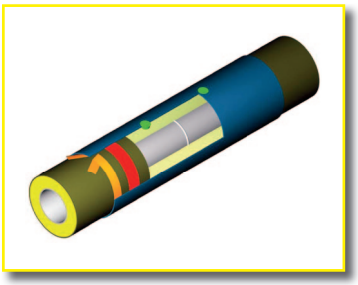
Thereafter and after recording of the agreed test procedures, the welding seams will be insulated and sealed with couplers and PUR-foam. Because of warranty reasons these works, except in case of **isocompact**-couplers, should be carried out by AGFW-/BFW-approved assembling specialists educated by **isoplus**-factory assembling personnel.

An identification mark will be fixed on all coupler connections carried out by **isoplus.**

This will allow an exact identification of the corresponding assembling engineer and will increase the quality requirement. In case that the post-insulation should be made by third parties, their qualification has to be proved by presenting of the AGFW-/BFW-test certificate, before beginning of the post insulation works.

isoplus has to be informed concerning this exceptional case before beginning of the works. The general valid **isoplus**-assembling guidelines, see **chapter 11.5.2** have to be generally considered.



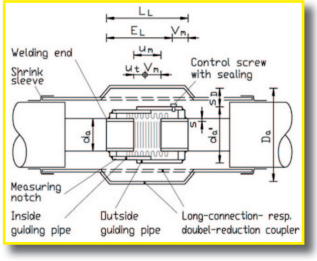


Edition: 16.01.2012

10.2.9 One-Time-Compensator

Preparation Works

The length- and measure values mentioned in this chapter, like [L_L], [u_m] etc. can be seen in data sheet **chapter 7.1.1**, and the **isoplus**-trench-design. The one-time-compensator (EKO) will be delivered with fully extended bellow, which means with the maximum possible expansion absorption [u_m]. The measure [u_m] corresponds exactly with the distance between the edge of the outer guiding pipe and the rotating notch at the inner guiding pipe.



ATTENTION: The factory made welding spots are only used for transportation security and should therefore be removed before any further works.

Delivery length [L_L] has to be cut about the mechanical prestressing measure [V_m]. Because of this the real from the pipeline expected expansion [u_t] will be adjusted. This will be decisive for the correct thermal prestressing of the EKO-system. For that the EKO has to be pressed together mechanically about the measure [V_m] by use of a suitable gripping tool. The required force [F] can be seen from data sheet, **chapter 7.1.1**. On request EKO´s can be pre-stressed. This will be generally the case starting from dimension DN 350, due to high forces.

The distance between the edge of the outer pipe and the notch of the inner pipe is now in accordance with the real expansion absorption [u_t], and the lengths of the EKO´s with the real installation length [E_L].At this status the both guiding pipes of the EKO´s will be connected with 2 - 3 welding points. This will fix the expansion length [u_t] adjusted for the installation. For the later pressure test of the pipeline no modification of the EKO length will be allowed. The measure [u_t] has to be adjusted identical for primary and secondary-EKO, because the circulating pre-heating- respectively starting medium in the primary and secondary line has to indicate the same thermal values.

Edition: 16.01.2012

Installation

Before EKO´s will be welded in, the long-connection- respectively long-double-reduction couplers have to slipped over the pipe bars. Due to reasons of Quality Safety of the total system, in consideration to sufficient insulation thickness and monitoring of the net-work, so called long-double-reduction couplers will be necessary for EKO´s up to the dimension of DN 200.

The EKO will be welded in exactly at the spots mentioned in the pipeline design, with the fixed status, like a piece of pipe. During this it has to be considered that no rough impurities will come into the inside located chrome-nickel-steel-bellow. Furthermore the control-screw for the tightness-test of the EKO should be at the upper area, between 11:00 and 13:00 o'clock. The same requirements as for all other steel-welding connections in the system, will be also relevant concerning the welding quality of both round-seams at the welding ends of the EKO´s.

The given distance measures between an expansion angle and an EKO, respectively between two EKO´s has to be guaranteed. EKO´s have to be installed generally between two, at least 6 m long straight pipe bars. The installation between bowed pipes or in elastic bowed sections, which means a bending load for the EKO´s, will be not admissible.

Furthermore it will be not allowed to cut the EKO, to use it for changing the direction respectively as compensation support in case of axis-bevelling and length-differences. Bevelling cuts are not allowed at the both welding seams. After welding in of the EKO´s the connecting points at the fillet seam may be **not** removed.

Weld-Seam-Test of Pipeline with installed EKO

After the welding works will be finished the welding seams have to be tested. During pressure test it should be considered, that the hydraulic restoring forces will be reliable compensated. Otherwise the adjusted expansion length [u_t] at the EKO´s may change in an unacceptable way, which could lead to a damage of the EKO´s.

Fixing of a restoring force-security directly at the EKO will be not allowed. In case that the EKO should be factory pre-stressed, the fixing will be just a security during transportation and during assembling. The fixing will be not suitable for transmission of restoring forces. Restoring forces [F] will be calculated as follows:

$$F = A \bullet p_p \quad [N]$$

A = effective bellow cross section in cm^2, see **chapter 7.1.1**
p_p = test pressure in bar

Edition: 16.01.2012

Insulation-, Sealing- and Earth Works

After the test procedures are finished and recorded, the welding seams have to be insulated by the AGFW-/BFW-approved and **isoplus**-educated assembling engineers, by use of the connection couplers which have been slipped on to the pipes before, however without the long-connection couplers at the welded EKO´s. Thereafter the expansion pads will be installed at all expansion angle and other corresponding longitudinal and thickness data as per **isoplus**-trench-design.

Thereafter the 10 cm sand-bed with a 0 - 4 mm grain (class NS 0/2 acc. to DIN 12620) has to be prepared and compressed manually at the complete pipeline, except of the EKO-areas. Now also the pipe trench, **except** of the EKO´s has to be re-filled and compressed manually with excavation material acc. to DIN 18196, see **chapter 9.5** and **9.6**.

The assembling pit at the EKO´s has to be big enough in order to carry out the final welding and insulation works without any problems. However it has to be considered that the length of the pit will not exceed the effective required space. This will guarantee that the pipes will not buckle horizontal or/and vertical during start of operation.

Start of Operation resp. Prestressing of the Pipeline

Before starting the operation of the pipeline, the stitch-spots at the fillet weld of the EKO´s **have to be detached**, in order to allow the compensation of expansion in the compensator-bellow. The heating of the pipes has to be carried out slowly and parallel, in order to avoid any temperature shocks.

If the pre-stress temperature of 80 °C has been reached, the adjusted and calculated expansion compensation **[u_i]** has to be checked. In case that the outside guidance pipe will appear at the circulating notch of the inner guidance pipe, the final position of the EKO has not yet reached and the heating temperature has to be increased.

ATTENTION: The final position of the EKO´s has to be reached!

Final Works resp. Final Assembling

If the final position of the EKO´s has been reached, the medium temperature has to be kept as long until the both guidance pipes will be welded with a fillet seam. Due to this a non-positive- and material connection has been carried out and the EKO will be considered just as a rigid piece of steel. The pipeline is now prestressed.

The fillet seam of the EKO has to be tested by an air-pressure test. Therefore a valve has to be screwed into the test drill at the upper third of the EKO. As test pressure 0,2 to 0,5 bar air will be sufficient. After testing the valve will be removed and the test drill will be tightly closed and welded by use of the also delivered screw.

Now the EKO will be insulated by the assembling engineers by using long connection couplers which have been slipped on to the pipes before. Finally only the sand-bed in the EKO-pit has to be prepared and compressed.

Edition: 16.01.2012

10.2.10 Tapping Branch

Preparation and execution of the tapping has to be made acc. to the guidelines of AGFW. That means a difference of nominal dimension of at least two dimensions, or i. e.: DN 150 has to be tapped with max. DN 100.

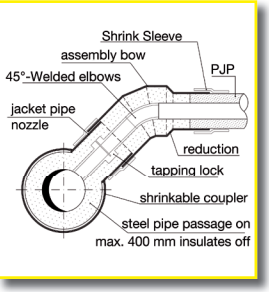
The tapping of a coupler connection is not allowed. Tapping locks have to be stored at temperature of – 5 °C to + 30 °C and a relative humidity of < 70 %. Thread and sealing areas may not be damaged.

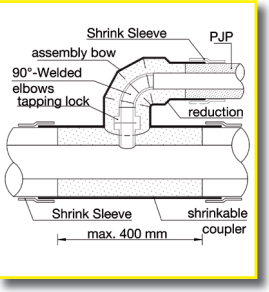
According to the passage pipe dimension the end of the lock without thread has to be adjusted without to shorten it. The tapping-lock will be welded electrically to the main pipe, by use of a 45°-exit with 45°-angle and in case of a parallel branch with 90°-angle. The lock-disc will be fixed at the handle and lubricated. The correct assembling of the lock can be checked by easy putting in and out of the disc.

It will be possible to check the weld seam before the tapping. The appropriate compass saw will be assembled at the tapping tool and the unit will be fixed at the tapping-lock. The drill spindle will be lowered until the grip-drill with gripping device will touch the passage pipe. Now the gear-unit will be fixed at the tapping unit and the tapping will be carried out under pressure with adjustable speed, depending from dimension.

After drilling the compass saw with spindle will be pushed slowly to the “off” position. Thereafter the lock-disc will be pushed into the slot of the tapping-lock. Now the gear and the tapping unit will be dismantled and the branch pipe will be welded to the tapping-lock. A pressure test against the tapping-lock will demonstrate the tightness of the connection.

The lock-disc can be removed now slowly from the tapping-lock, in order to avoid any pressure shock, and the slot of the tapping-lock can be welded electrically. Finally the exit will be post insulated by **isoplus**-factory educated assembling engineers, by use of a PEHD-assembling branch, see **chapter 6.11.1**. Detailed assembling information will be available on request.

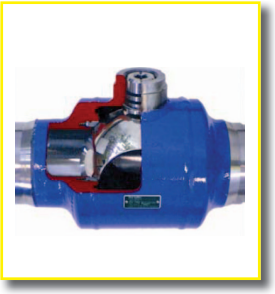




Edition: 16.01.2012

10.2.11 One-Time-Valve

Single-use and on-demand connection ball valves can be used to close off a construction section which will be continued at a later date. The available **isoplus** route can be continued at any time without requiring the pipeline to be emptied and taken out of operation if welded in as an end piece.

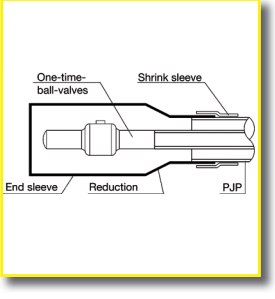


Single-use ball valves will be welded into the route in a closed position like a piece of pipe. In connection with double pipes, make sure that the assembly of the ball valve occurs clockwise and relocated along the longitudinal axis.

To prevent contamination and to prevent the polyethylene foam from penetrating into the open end of the ball valve, assembly of a dished bottom and a pipe cap in accordance with DIN EN 10253-2 is required. We recommend leaving the ball valve in the open position. This ensures that seat rings and ball are surrounded by water, making the seat rings are greased and the surface of the sphere is protected against deposits.
For use up to temperatures at least in accordance with EN 253 operating temperature and 25 bar operating pressure.

Post-insulation is made using an end joint. It is necessary that this end joint is being delivered with a widened or enlarged diameter in order to ensure the necessary insulation thickness, like **chapter 7.1.3**.

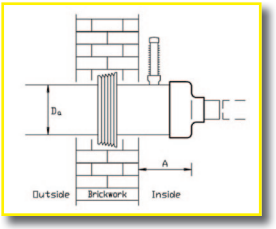
Once the continuing section has been installed, assembled, and welded to the single-use ball valve, commissioning may take place. For this purpose, the closing screw of the single-use ball valve will be operated using a screwdriver or a hexagon Allen key and then welded.



Edition: 04.10.2012

10.2.12 End Cap

The pipe layer will be responsible for putting the end caps on to the pipes in the buildings or in manholes, before connection to the conventional continuing pipelines. Fixing in the PJP-ends in a wall without end cap is not allowed. The alarm wires have to be kept free until to the final assembling, they may not be fixed in a wall and not pulled off. End caps may not cut open and have to be protected from heat and combustion during welding works. Cut up end caps are excluded from assembling.



Before shrinking of an end cap, the PEHD-jacket-pipe end has to be degreased by use of a PE-cleaner. Thereafter the jacket-pipe and the steel pipe has to be roughen with an emery linen on a width of approx. 100 mm. Remove PE- and steel particles.

The shrinking of the end cap will be continued with a soft propane gas flame of at least 60 °C in circumference direction. Thereafter let it cool down. Now the shrinking procedure will be continued at the annular gap and at the steel pipe. The shrinking procedure will be finished as soon as the sealing adhesive will expose at the edges.

Due to warranty reasons the shrinking of the end caps should be carried out by the AGFW-/BFW-approved and **isoplus**-factory educated assembling engineers.

At medium temperatures > 120 °C the end caps have to be fixed additionally with stainless-strap retainers, as well at carrier- as also at jacket-pipe.

Minimum-Excess **[A]**:

PEHD-Jacket-Pipe Diameter D_a in mm	from	65	250	450	710	1000
	to	225	400	670	900	1300
PEHD-Jacket-Pipe Excess A in mm		100	125	150	200	250

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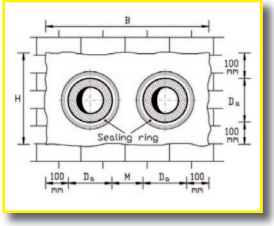
10.2.13 Wall Duct - Sealing Standard

The dimension of the wall duct respectively the core drill is depending from the PEHD-jacket-pipe, the number of pipes and from the kind of sealing.

Sealing Ring - Standard

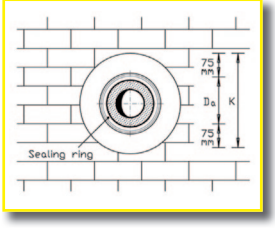
The neoprene ring has to be slipped on in the middle of the brickwork and should not lie on. The mentioned passing through size will allow a correct concrete-pouring. At dimensions ≥ DN 400 it will be recommended to slip on two sealing rings per pipe and to wrap the space in between with a grease-band. The admissible angle of the pipe to the wall will be max. 30°.



The mentioned minimum measures have to be kept strictly. The total size will be calculated as follows:

$$B = x \bullet D_a + M \bullet (x - 1) + 200 \ [mm]$$

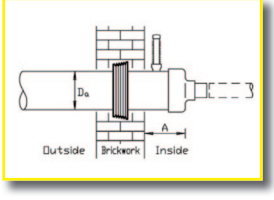
$$H = D_a + 200 \ [mm]$$



x = Number of pipelines
D_a = Jacket-Pipe Outside-Diameter in mm
M = clear distance between Jacket-Pipes, acc. to **chapter 9.2.3**

At the pipe duct through a concrete wall also a core drill [K] can be provided. At installation of the standard sealing ring the drill should be at least 150 mm bigger than the PEHD-jacket-pipe diameter.

$$Ø\ K = D_a + 150 \ [mm]$$



Minimum-Excess [A]:

PEHD-Jacket-Pipe-Diameter D_a in mm						
	from	65	250	450	710	1000
	to	225	400	670	900	1300
PEHD-Jacket-Pipe Excess A in mm		100	125	150	200	250

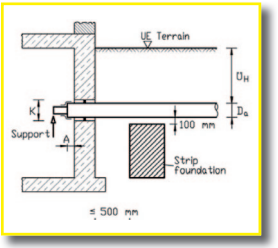
Edition: 16.01.2012

10.2.14 Wall Duct - Sealing Insert

The press-water tight insert will be installed into a pipe liner or a core drill [K]. The mentioned drill diameters should be strictly kept, because the width of the C 40 - insert will match the ring-space gap. The sealing will end with the outside of the wall and can be re-stretched from inside of the building respectively inside of the manhole. The admissible angle to the wall will be max. 8°. For the jacket-pipe excess [A] analogous the table in **chapter 10.2.13** will be valid. The mentioned core drillings are valid only for type C 40. **isoplus** will not guarantee for the correctness of the diameters in case of using any other type!

The pipeline has to be tightened carefully at the building entry in case that sealing inserts will be used, in order to avoid settlements. Additional the pipeline should be supported in the building or in the house. The special sealings can compensate only slight axial movements up to 20 mm.

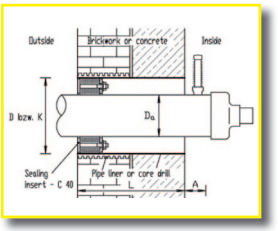
ATTENTION: Radial loads or soil-settlements at the building or manhole entry will cause leaks. This should be avoided by efficient compressing of the soil and by support constructions in the manhole or in the building. A discharge of pressure can be reached by a stripe-foundation before the building edge.



Jacket-Pipe-Ø D_a in mm	65	75	90	110	125	140	160	180	200	225	250	280	315	355
Diameter Core Drill K in mm	125	125	150	200	200	200	250	250	300	300	350	350	400	450

Jacket-Pipe-Ø D_a in mm	400	450	500	560	630	670	710	800	900	1000	1100	1200	1300	isoplus
Diameter Core Drill K in mm	500	600	700	700	800	800	800	900	1000	1100	1200	1300	1400	

The pipe-liner made of special synthetic fibre cement (SFC) acc. to DIN 19800 consists of a pressure pipe PN 6, outside grooved, corrosion resistant and not electrically conducting. It has to be already fixed and positioned during the construction works. The inner diameter [D] is correspondent with the diameter of the core drill [K]. The length of the pipe-liner [L] is depending from the thickness of the wall. It will be available in standard length 200, 240, 250, 300, 365, 400, 500, 650 and 1000 mm.



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10.2.15 Leak Detecing

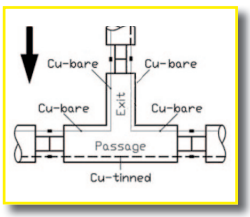
IPS-Cu* & *IPS-NiCr

The leak detecting wires foamed in into the pipe bars and components will be connected during the postinsulation works by approved assembling engineers. All wires are different in colour, in order to avoid wire connection failures.

During pipe assembling the wires have to be aligned to 11:00 o'clock respectively 13:00 o'clock. Do never change the wire codification. Due to warranty reasons the final wiring, that means the assembling of all **IPS-Cu** and **IPS-NiCr** accessories as well as units, will be carried out exclusively by the approved and **isoplus**-factory educated assembling engineers. After completion of these works a measure- respectively acceptance report has to be prepared.

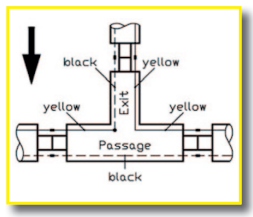
IPS-Cu	IPS-NiCr
Wire Connection: Decoil bare Cu-wire ends, stretch carefully and cut to abut, degrease and draw bright by use of sandpaper. Thereafter press right colours with squeeze husks and solder additionally, which will avoid high transition resistances. Fix two wire-distanceholders at pipe and fix the wires on it. Check measurement on each coupler and in both directions.	**Wire Connection:** Decoil wire ends, stretch carefully, strip the insulation of yellow NiCr-wire with 10 mm overlengths, cut black wire to abut, cut and strip the insulation. Pull shrink-hose approx. 70 mm over both wires. Connect black wires to abut, yellow wires overlapping with squeezing husks, 2 x squeezed. Shrink shrinking-hose above the husks. Fix two wire distance holder at the pipe and fix the wires on it. Check measurement on each coupler to the left and to the right.
Branch wire connection resp. rule: The bare copper wire has to be connected always to the right to the main pipeline on the bare copper wire, the tinned copper wire always to the left on the bare copper wire, seen from the branchpipeline to **direction of arrow**, without consideration whether the branch has been installed outgoing topside or at the bottom. The tinned copper wire of the passage has to be wired straight through the branch. Eventually the course of the foamed in Cu-wires in the preinsulated branch has to be checked by an ohmmeter.	**Branch wire connection resp. rule:** The black wire of the passage has to be wired straight through the branch. Eventually the course of the foamed in NiCr-wires in the branch has to be checked by an ohmmeter. **Branch upward:** Connect the yellow wire to the left to the main pipeline on yellow, the black wire to the right on yellow, seen from the branch-pipeline to direction of arrow. **Branch downward:** Connect the yellow wire to the right to the main pipeline on yellow, the black wire to the left on yellow, seen from the branch-pipeline to direction of arrow.

IPS-Cu



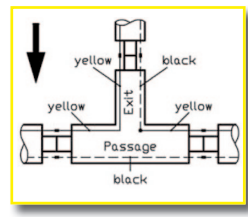
Branch

IPS-NiCr



Branch **upward**

IPS-NiCr



Branch **downward**

10.2.16 Thermal Prestressing

Pipe Laying and Weld-Seam-Test

The PJP-pipeline will be assembled according to the **isoplus**-laying guidelines on assembling supports or directly on the sand-bed. Before the welding of the pipes and components, the corresponding connection couplers with the shrinking sleeves have to be slipped on the jacket-pipe beside of the welding spot.

After completion of the welding works, the welding seams have to be checked in accordance to the agreed extend between buyer and supplier. Obvious damages are classified in DIN EN ISO 17637. Subsequently, the non-destructive weld test must be carried out in an environment to be determined. In case of a radiographic test, test class B of DIN EN 1435 is desirable. After the non-destructive test, the leakage and/or sealtightness test must be carried out in accordance with AGFW Information Sheet FW 602.

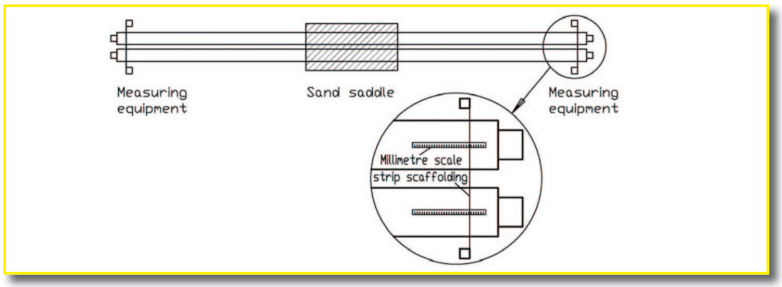
The visual inspection method using air is recommended compared with that using water in a control test; during the test the welds are coated with a foaming agent. If no froth bubbles form within at least 1 minute, its state of sealtightness is considered proven. For the method using internal air overpressure the test pressure is 0,2 to 0,5 bar, with external air underpressure (vacuum glasses) an absolute maximum of 0,6 bar.

A cold water pressure test must be carried out on the vented route in accordance with the DVGW Worksheet G 469, Procedure A1. The test pressure is 1,3 x the operating pressure at its highest point and must be maintained for 3 hours.

Insulation- and Sealing Works

After the test procedure will be completed and recorded, the welding spots will be insulated by the AGFW-/BFW-approved and **isoplus**-factory educated assembling engineers, by use of the connection couplers which have been slipped over the pipes before, but without the long-connection couplers at eventually necessary fitting pieces respectively measuring systems.

Thereafter the expansion pads will be assembled at the expansion angle like L-, Z- and U-elbows as well as at all other required spots in correspondence to the length- and thickness data of the **isoplus**-trench-design.



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Preparation Works

After the insulation works the prestressing section **has to be** checked concerning obstacles like roots etc. which will eventually obstruct the expected unimpeded extension, and whether they can be removed.

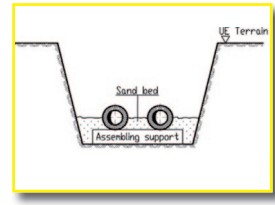
Branch pipelines should be excluded from the prestressing procedure in case that they are part of the prestressing section. T-branches can be used as intermediate measuring spots. However if branch pipelines have to be included into the prestressing, it should be also considered that the unimpeded extension of the pipeline will not be blocked.

In case that the prestressing section will run parallel to a front of houses or other buildings in a distance of ≤ 5 m, the corresponding wall ducts should be fixed respectively covered with concrete first after completion of the thermal prestressing. Without considering this, the damage of the sealing rings and the preinsulated jacket-pipes will be pre-programmed. This will lead to a warranty exclusion.

For an exact recording of the prestressing, the measuring installations mentioned in the **isoplus**-trench-design have to be installed as a fix profile. For that it will be helpful to fix a weather resistance millimetre scale on the jacket-pipe.

Thereafter the prestressing section up to the pipe axis, that means up to 3:00 respectively 9:00 o'clock position, has to be filled orderly with sand in layers, grain 0 - 4 mm (class NS 0/2 acc. DIN EN 12620) which has to be compressed manually.

The assembling space between the pipes should especially be considered. The fitting pieces and the measuring installation will not be filled with sand.



Thereafter the sand-saddle respectively the supporting fix-point has to be filled and compressed to the upper edge of the soil- respectively street, in accordance to the concept. The saddle has to be provided at road crossings or eventual existing bowed pipes. As an advantage these areas may then be sanded and filled completely with excavation material.

The bowed pipes **have to be** supported lateral in case that the sand-saddle cannot be placed. Additionally the sand-bed has to be completed **only** on the complete length of the bowed pipes up to 10 cm above the pipe crown. These two measurements will guarantee that the axial pipe extension will move over the bowed pipes during the prestressing, and that these will not buckle horizontal or vertically.

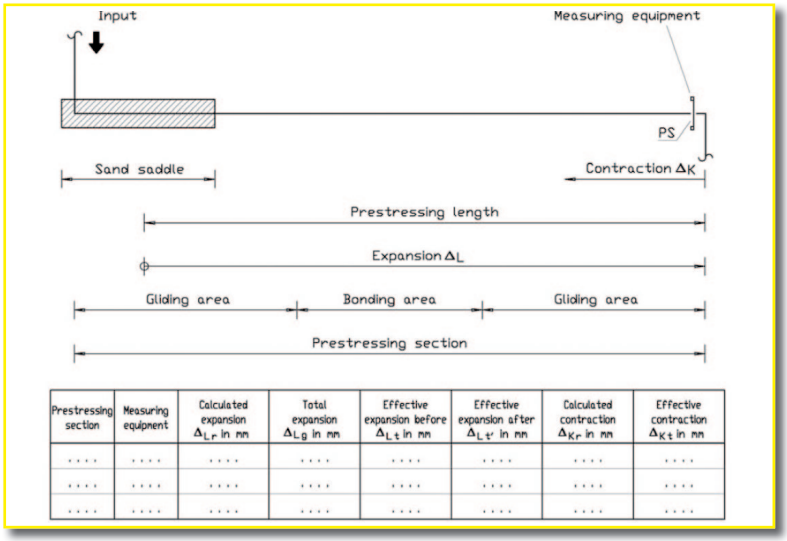
If the free expansion should be provided one-sided, i. e. in case of a prestressing with the operating medium from the heating plant, the sand-saddle has to be filled at the end of the opposite side of the measuring spot. This end at the sand-saddle has to be supported additionally lateral, in order to guarantee an one-sided unimpeded expansion movement. In case of a prestressing with the existing medium the sand-saddle can be placed just at one end of the prestressing section, and has not to be placed in the middle.

Execution and Recording

The length- and measuring data described in this section, like [ΔL_r], [M_L] etc., can be seen from the **isoplus**-trench-design and from the prestressing concept. Heating of the pipes has to be carried out slowly and parallel, in order to avoid any temperature shocks.

As soon as the prestressing temperature [V_T] has been reached, it has to be kept constant. The calculated unimpeded modification of length [ΔL_r] will be checked at the measure installations and recorded. The effective result [ΔL_t] will be recorded in the concept.

ATTENTION: The prestressing temperature [V_T] has to be kept, the effective expansion movement [ΔL_t] may slightly differ from the calculated value [ΔL_r]. In case of bigger differences the responsible design and construction manager or/and engineer has to be informed!



Prestressing section	Measuring equipment	Calculated expansion ΔL_r in mm	Total expansion ΔL_g in mm	Effective expansion before ΔL_t in mm	Effective expansion after ΔL_t in mm	Calculated contraction ΔK_r in mm	Effective contraction ΔK_t in mm
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....

Thereafter the 10 cm sand-bed (class NS 0/2) has to be established and compressed manually all over the total prestressing section, except of the measure installations. Now the pipe trench **has to be** refilled and compressed with excavation material, except of the already mentioned spots, according to DIN 18196, ZTV A - StB just as ZTV E StB.

The prestressing temperature has further to be kept.

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If the re-filling of the total prestressing section cannot be made in one procedure, the minimum filling length [M_L] on both sides have to be **strictly** kept. It will be not admissible to distribute the required soil on to the total section length. The remaining length [R_L] should be filled thereafter, however the trench at this area may be also filled later on.

The change of length [ΔL_r] will be checked again at the measuring equipment and the read off result [ΔL_t] will be also mentioned in the protocol. Thereafter the prestressing unit can be switched off. However the measuring equipment will still remain in order to check the calculated length contraction [ΔK_r] after the cooling period and in order to secure the measured result [ΔK_t] in the protocol.

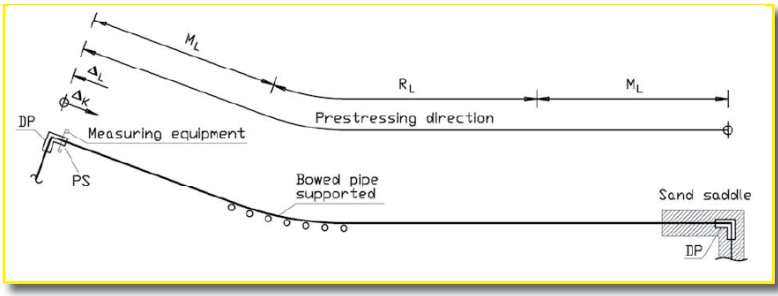
At prestressing of several sections following after each other, the contraction [ΔK] has to be added to the unimpeded expansion [ΔL] , in order to reach the total change [ΔL_g]. Additional has to be considered that the sliding areas have to be defined again after every section at the stage- respectively step-back prestressing procedure.

For registering of all Δ-values it will be strictly necessary that the client will determine a responsible chief construction manager, who will also supervise the prestressing procedure and who will confirm with his signature the effective data in the protocol respectively in the concept.

Final Works resp. Final Assembling

At the completion of the prestressing, recorded in the concept and in the report, the measuring equipment has to be removed and the pre-heated fitting pieces (PS) should be welded in. Fitting pieces should be as short as possible. This can be reached under consideration that the assembling gap for a fitting piece may correspondent maximum to the 1,5-fold of the unimpeded expansion movement [ΔL].

Thereafter the fitting piece will be insulated by use of the long-connection coupler slipped over before, the expansion pad (DP) will be assembled at these areas and the sanding and re-filling of the remaining pipeline will be carried out.



PROCESS REPORT THERMAL PRESTRESSING

Working Step	
	Customer: _____ **Project:** _____ **Street:** _____ **PC / City:** _____ **Prestressing Section:** **Project-No.:** _____
1	Responsible operating personnel: _____ Delivery from: _____ date _____ from _____ ◷ at _____ km Arrival in: _____ date _____ at _____ ◷ at _____ km
2	Current supply existing: yes ❑ no ❑ Fitting piece gaps available: yes ❑ no ❑ Section acc. to drawing: yes ❑ no ❑ Measuring system available: yes ❑ no ❑
3	Aggregate installation: date _____ from _____ ◷ to _____ ◷
4	Sand-saddle acc. to drawing: yes ❑ no ❑ Guiding sand-bed existing: yes ❑ no ❑ Branches re-filled: yes ❑ no ❑ Bowed pipes supported: yes ❑ no ❑
5	Steel pipe temperature before: _____ °C Ambient temperature: _____ °C Weather conditions: _____
6	Aggregate employed: date _____ at _____ ◷ Heat up phase: from _____ ◷ _____ to _____ ◷ Prestressing temperature reached: date _____ at _____ ◷ Steel pipe temperature at protocol of ΔL_t - values: _____ °C
7	Sand-bed in order: yes ❑ no ❑ Minimum filling lengths kept: yes ❑ no ❑
8	Aggregate stopped: date _____ at _____ ◷ Heat down phase: from _____ ◷ _____ to _____ ◷ Prestressing completed: date _____ at _____ ◷ Steel pipe temperature at protocol of ΔK_t - values: _____ °C
9	Aggregate dismounting: date _____ from _____ ◷ to _____ ◷
10	Overtime total: _____ hrs. Night work total: _____ hrs. Sunday work total: _____ hrs. Holiday work total: _____ hrs.
11	Removal from: _____ date _____ from _____ ◷ at _____ km Arrival at the next project: date _____ at _____ ◷ at _____ km Entire driven kilometer: _____ km
12	Comment/Explanation: _____
13	_____ Date _____ Signature + Name Responsible engineer _____ Signature + Name Operating personnel

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Prestressing of Expansion-Angle resp. -Pad

The length reductions of L-, Z- or U-elbows as well as those of the expansion pads thickness by thermal prestressing, is a well known and in the pipeline construction accepted technology, which will be mainly used for bigger dimensions and especially in the accepted “Operational Self Prestressing” technology. It will be used wherever essential change of length have to be compensated or if the normal calculated length cannot be reached by use of an expansion branch, due to local regulations.

Practically this minimisation can be reached by using the thermal prestressing procedure. This will be made by subsequent sanding and filling of the expansion pads. The first expansion of the pipes has not been compensated by the pads, only the remaining movement will be compensated by the pads. The static calculations will be made not with the effective pre-heating temperature [V_T], but with a hypothetical pre-heating temperature [V_{Tf}], in order to simulate the occurring friction forces [F‘$_R$].

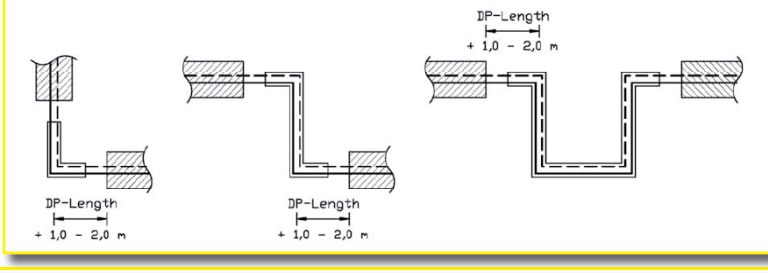
$$V_{Tf} = T_E + \frac{T_B - T_E}{3} \quad [°C] \qquad \text{i. e.:} \qquad V_{Tf} = 10 + \frac{130 - 10}{3} = 50\ °C$$

Because of this calculated necessary step, the first expansion of the pipeline will be no longer statically considered.

In contrary to the thermal prestressing at open pipe trench, no protocol will be required at the expansion branch- respectively expansion pad- prestressing. The working procedure can be carried out analogous to point **1.** and **2.** of the already described process. Fitting pieces will be not required. Thereafter the following working steps will be carried out:

1. Expansion pads will be assembled at L-, Z- or U-elbows in tension free position at cold pipeline. In contrary to the mechanical prestressing these areas will be **not** sanded and filled or compressed.

2. Now the complete PJP-pipeline will be sanded, filled and compressed up to approx. 1 - 2 m before the expansion pads, according to the standard and to the guidelines. The open areas can be seen from the **isoplus**-trench- respectively from the pre-heating design.

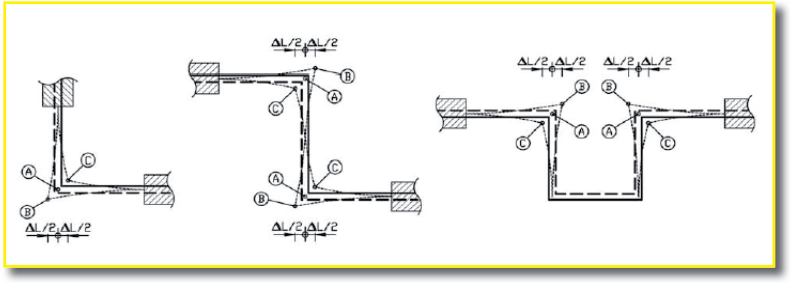


3. Thereafter the net will be put in operation or heated up to the effective prestressing temperature [V_T] of i. e. 70 °C (T_B = 130 °C), by use of a mobile prestressing unit.

4. As soon as V_T will be reached the sand-bed will be carried out at the still open padding areas in order to fill and to compress these pits thereafter. The prestressing temperature **has to be** kept constant. The expansion branches are now free of tension.

5. Therefore the first expansion will be not be compensated by the expansion pads and the branch will be pre-stressed about 50 %.

6. During heating to the maximum operating temperature [T_B] of i. e. 130 °C point ***A*** will move to ***B*** about ΔL/2 respectively to ***C*** when cooling down to 10 °C also about only ΔL/2.



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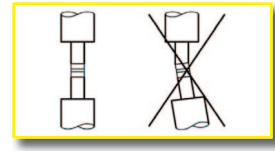
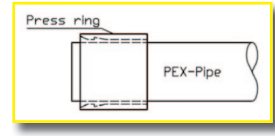
10.2.17 Assembling Connection Coupler isopex

The **isopex**-pipe will be cutted rectangular, and insulated to a maximum lengths of 150 mm. Both pipe ends should touch straight respectively absolutely plain against each other, as this system allows generally no crease or angles.

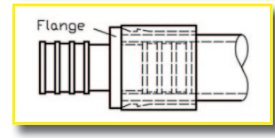


After cutting and removing of insulation the pipes should be ridged by use of a suitable tool.

ATTENTION: The red diffusion barrier of the heating pipe may not be damaged. Thereafter the pressring has to be put on to the **isopex**-pipe and the PEX-ends should be enlarged two times by using a expanding pincer, for a period of 5 seconds and shifted by 30°.



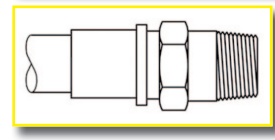
The connection part should be put into the **isopex**-pipe end up to the stop position of the flange. Thereafter the press ring should be pressed to theflange of the connecting part; eventually a rubberor wooden-hammer may be used.



The press-pincer (can be bought or rented, see **chapter 7.2.1** will now put in position and pressing will be carried out in a way that the blocks of the pincer, respectively the rings will touch each other at the flange.

Before the pressing procedure all materials have to be cleaned. Lubricating of the pipe will be helpful. At assembling temperatures about ± 0 °C the carrier pipe should be warmed up carefully to ≈ 20 °C by using a hot air-blow

Fitting couplings will be assembled with the pipes to the outside thread or to the welding end. In case that a fitting coupling with press fitting and welding end will be used as end piece in the soil, the following has to be considered:



Before the fitting coupling will be pressed, a piece of steel pipe with a minimum length of 200 mm has to be closed with a torospherical head. This piece of steel pipe will be welded autogenously or electrically to the welding end. Thereafter the prepared component will be pressed on to the **isopex**-pipe. Post insulation will be made by use of a long-end coupler.

The next step of assembling will be to cut off the coupler and the torospherical head and the next fitting coupling will be welded. The previous pressing has to be cooled in order to avoid that it will get loose. Thereafter again the fitting coupling will be assembled on to the **isopex** pipe. Post insulation will be made by use of long-connection coupler. Possible kind of couplers see **capter 6.**

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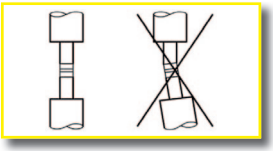
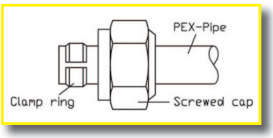
The **isopex**-pipe will be cutted rectangular, and insulated to a maximum lengths of 150 mm. Both pipe ends should touch straight respectively absolutely plain against each other, as this system allows generally no crease or angles.

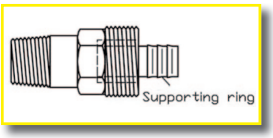


After cutting and removing of insulation the pipes should be ridged by use of a suitable tool.

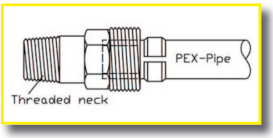
ATTTENTION: The red diffusion barrier of the heating pipe may not be damaged. Thereafter the screwed-caps should be pushed with the clampring on to the **isopex**-pipe.



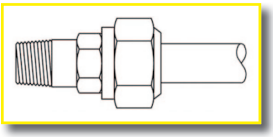
For pipe dimensions 90 and 110 mm the supporting ring should be pressed manually into the pipe, by using a rubber-hammer. Any damages of the support-ring and the pipe end should be avoided.



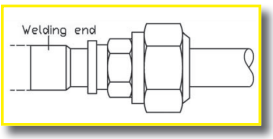
Now the **isopex**-pipe end should be pressed into the cylindrical-threaded-neck until to the stop position.



Thereafter the screwed-cap should be fixed sufficiently. Screwed connections for **isopex**-pipes with a minimum temperature of approx. 60 °C - 80 °C should be fixed again as soon as they have reached the operating temperature. For post insulation with PUR-foam at the connection spots, the temperature should be drop down to 45 °C.



In case of fitting couplings the assembling of the continuing pipe will be made to the outside thread or to the welding end.



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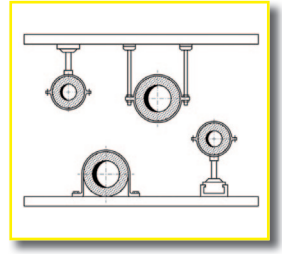
10.3.1 General / Method of Pipe-Laying / Transition Free- to Buried Laying

General

In case of spiro-fold jacket-pipes for open line constructions inside or outside of buildings, as well as in case of preinsulated PEHD-jacket-pipes inside of buildings, the pipe layer has to provide and to install the additional required assembling scaffolds, until the pipe laying and post-insulation works will be completed. Also a third party will be responsible for the procurement of the required support- and supporting structure, in pendulous construction, or sliding bearing.

The relevant regulations for prevention of accidents as well as the required combustion-, cold-, sonic-, heat-, or/and civil defence have to be kept. The pipe clamps respectively -bearings have to be fixed only at the jacket-pipe of all **isoplus**-pipes. This will effective avoid that any moisture-, cold-, or/and heat-bridges will occur.

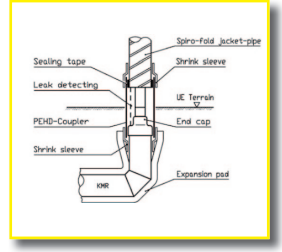
Method of Pipe-Laying



The pipe-laying can be made as high-, socle- or/and support line as well as on a pipe-bridge in spandrel-braced or hanging version. All methods of pipe-laying have to guarantee a sliding respectively pendulous bearing, due to the eventually occurring change of pipe length. It has to differentiate between compound and sliding system.

In case of a compound pipe the three frictional connected components (carrier pipe + insulation + jacket-pipe) will constantly expand in axial direction. At the sliding system only the carrier pipe will expand, because of the missing frictional connection to the insulation respectively to the jacket-pipe.

Transition Free- to Buried Laying



Providing that a static approval will be available, direct transitions from buried preinsulated pipes to open line layed spiro-fold jacket-pipes may be assembled without any restrictions. However it has to be considered that the last metal coupler should be installed 100 % outside of the soil-area.

Within this metal coupler an end cap has to be installed additionally as system-separation, according **chapter 10.2.12.** The upward PJP-elbow in the soil-area has to be equipped with expansion pads in accordance to the **isoplus**-trench-design.

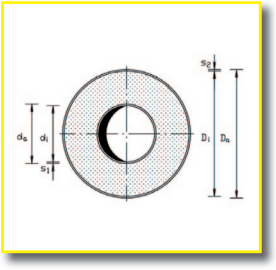
10.3.2 Bearing Distance

Bearing Distance

In order to determine the possible respectively maximum admissible bearing distance [L_S] of a pipeline, the following parameter should be known:

⇒ Admissible pipe bowing [f] in mm
⇒ Moment of inertia of the pipe [I] in cm⁴
⇒ Own pipe weight [F'$_G$] in kg/cm

The pipe bowing [f] in the middle of the field should be between 2 mm and maximum 4 mm.



For better interpretation the following formula are mentioned parallel with an example. For this will be valid: DN 150 (d_a = 168,3 mm; s_1 = 4,0 mm; d_i = 160,3 mm) with PUR-insulation and PEHD-jacket-pipe (D_a = 250,0 mm; s_2 = 4,5 mm; D_i = 241,0 mm). As carrier pipe a black steel (P235GH) filled with water has been considered.

The moment of inertia [I] will be calculated as follows:

$$I = \frac{\pi}{64} \bullet (d_a^4 - d_i^4) \ [cm^4] \quad \Rightarrow \quad I = \frac{3{,}1416}{64} \bullet (16{,}83^4 - 16{,}03^4) \ [cm^4]$$

Result: $I = 697{,}09 \ cm^4$

π = 3,1416 [-]
64 = Constant [-]
d_a = Outside diameter jacket-pipe [cm]
d_i = Inside diameter medium-pipe [cm]

For the pipe weight force [F'$_G$] will be valid:

$F'_G = G_{IR} + G_{D\ddot{A}} + G_{AR} + G_{MF}$ [kg/m] ⇒ $F'_G = 16{,}25 + 1{,}87 + 3{,}30 + 20{,}18$ [kg/m]

Result: $F'_G = 41{,}60$ kg/m or: $F'_G = 0{,}416$ kg/cm or: $F'_G = 41{,}60 \bullet 9{,}81 = 408{,}10$ N/m

The single weight [G_{xy}] will be calculated as follows:

G_{IR} = Weight inside resp. carrier pipe $G_{IR} = (d_a - s_1) \bullet \pi \bullet s_1 \bullet l \bullet \rho_{IR}$ [kg/m] $G_{IR} = (1{,}683 - 0{,}04) \bullet 3{,}1416 \bullet 0{,}04 \bullet 10 \bullet 7{,}87$ Result: G_{IR} = 16,25 kg/m	$G_{D\ddot{A}}$ = Weight insulation $G_{D\ddot{A}} = [(D_i : 2)^2 - (d_a : 2)^2] \bullet \pi \bullet l \bullet \rho_{D\ddot{A}}$ [kg/m] $G_{D\ddot{A}} = [(2{,}41 : 2)^2 - (1{,}683 : 2)^2] \bullet 3{,}1416 \bullet 10 \bullet 0{,}08$ Result: $G_{D\ddot{A}}$ = 1,87 kg/m
G_{AR} = Weight outside resp. jacket-pipe $G_{AR} = (D_a - s_2) \bullet \pi \bullet s_2 \bullet l \bullet \rho_{AR}$ [kg/m] $G_{AR} = (2{,}5 - 0{,}045) \bullet 3{,}1416 \bullet 0{,}045 \bullet 10 \bullet 0{,}95$ Result: G_{AR} = 3,30 kg/m	G_{MF} = Weight filling of carrier pipe $G_{MF} = (d_i : 2)^2 \bullet \pi \bullet l \bullet \rho_{MF}$ [kg/m] $G_{MF} = (1{,}603 : 2)^2 \bullet 3{,}1416 \bullet 10 \bullet 1{,}0$ Result: G_{MF} = 20,18 kg/m

ρ_{xy} = Material apparent density
ρ_{IR} = 7,87 kg/dm³ (Steel)
ρ_{AR} = 0,95 kg/dm³ (PEHD)

d_a = Outside diameter carrier pipe [dm]
d_i = Inside diameter carrier pipe [dm]
s_1 = Wall thickness carrier pipe [dm]

l = 10 dm
$\rho_{D\ddot{A}}$ = 0,08 kg/dm³ (PUR)
ρ_{MF} = 1,00 kg/dm³ (Water)

D_a = Outside diameter jacket-pipe [dm]
D_i = Inside diameter jacket-pipe [dm]
s_2 = Wall thickness jacket-pipe [dm]

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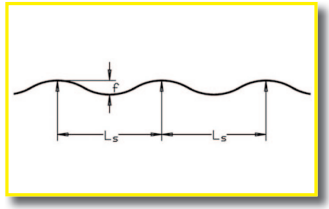
For determining the bearing distance [L_S] for pipes on three bearings will be valid:

$$L_S = \sqrt[4]{\frac{f \bullet I}{F'_G \bullet 2{,}48}} \quad [m]$$

$$L_S = \sqrt[4]{\frac{4 \bullet 697{,}09}{0{,}416 \bullet 2{,}48}} \quad [m]$$

Result (PEHD-MR): L_S = 7,21 m



f = Admissible bowing [mm]
I = Moment of inertia [cm⁴]
F'G = pipe weight force [kg/cm]
2,48 = Constant [-]

d_a = Outside diameter carrier pipe

s = Wall thickness carrier pipe acc. to **isoplus**

D_a = Outside diameter jacket-pipe

G = Weight pipe incl. water

f = Admissible pipe bowing

L_S = Bearing distance f. bearing to bearing

B_{SCH} = Required bearing- resp. clamp width

Dimensions carrier pipe				Jacket-pipe (MR) standard					
Norminal Diameter		Outside-Ø D_a	Wall-thickn. s	Outside-Ø D_a	Weight G	f = 2 mm		f = 4 mm	
DN	Inches	in mm	in mm	in mm	in kg/m	L_S in m	B_{Sch} in mm	L_S in m	B_{Sch} in mm
20	¾“	26,9	2,3	90	0,036	2,35	10	2,80	10
25	1“	33,7	3,6	90	0,044	2,75	20	3,27	20
32	1 ¼“	42,4	3,6	110	0,059	3,07	20	3,65	20
40	1 ½“	48,3	3,6	110	0,066	3,30	20	3,93	20
50	2“	60,3	3,6	125	0,090	3,73	30	4,43	30
65	2 ½“	76,1	3,6	140	0,120	4,16	30	4,95	40
80	3“	88,9	3,6	160	0,156	4,50	40	5,35	40
100	4“	114,3	3,6	200	0,235	5,07	50	6,03	60
125	5“	139,7	3,6	225	0,312	5,51	60	6,56	70
150	6“	168,3	4,0	250	0,422	6,04	80	7,18	100
200	8“	219,1	4,5	315	0,679	6,75	110	8,03	130
250	10“	273,0	5,0	400	1,006	7,42	140	8,82	170
300	12“	323,9	5,6	450	1,358	8,06	190	9,58	220
350	14“	355,6	5,6	500	1,592	8,31	200	9,89	240
400	16“	406,4	6,3	560	2,044	8,89	250	10,58	290
450	18“	457,2	6,3	630	2,527	9,22	280	10,97	330

Diameter in DN	Jacket-pipe (MR) 1x reinforced						Jacket-pipe (MR) 2x reinforced					
	Outside-Ø D_a in mm	Weight G in kg/m	f = 2 mm		f = 4 mm		Outside-Ø D_a in mm	Weight G in kg/m	f = 2 mm		f = 4 mm	
			L_S in m	B_{Sch} in mm	L_S in m	B_{Sch} in mm			L_S in m	B_{Sch} in mm	L_S in m	B_{Sch} in mm
20	110	0,041	2,27	10	2,70	10	125	0,046	2,21	10	2,63	10
25	110	0,049	2,67	10	3,17	20	125	0,054	2,61	10	3,10	20
32	125	0,063	3,01	20	3,58	20	140	0,068	2,96	20	3,52	20
40	125	0,071	3,25	20	3,87	20	140	0,075	3,20	20	3,80	20
50	140	0,095	3,68	20	4,38	30	160	0,102	3,62	20	4,30	30
65	160	0,127	4,10	30	4,88	30	180	0,134	4,05	30	4,81	30
80	180	0,163	4,45	40	5,29	40	200	0,171	4,40	30	5,23	40
100	225	0,245	5,01	50	5,96	50	250	0,256	4,96	40	5,90	50
125	250	0,323	5,46	60	6,50	70	280	0,337	5,40	50	6,43	60
150	280	0,437	5,99	80	7,12	90	315	0,470	5,88	70	6,99	80
200	355	0,704	6,69	100	7,95	120	400	0,734	6,62	100	7,87	110
250	450	1,043	7,35	130	8,74	160	500	1,083	7,28	120	8,66	150
300	500	1,398	8,00	170	9,51	200	560	1,449	7,93	160	9,43	190
350	560	1,643	8,25	190	9,81	220	630	1,740	8,13	170	9,67	210
400	630	2,141	8,79	230	10,45	270	670	2,183	8,75	220	10,40	260
450	670	2,569	9,19	270	10,92	320	710	2,614	9,15	260	10,88	310

All weight data are valid for carrier pipes acc. to **isoplus** with SPIRO-jacket-pipe **incl.** water content.

10.3.3 Pipe Clamps

Concerning the construction of pipe clamps we have also to differentiate between compound- and sliding system. At compound pipes the clamps may not obstruct the expected expansion movement, that means they have to include a sliding insert or they have to be fixed on axial-, and near to the expansion elbows also on lateral flexible pipe bearings.

In case of sliding systems the pipe clamps may be fixed directly at the jacket pipes, as this will move only slightly. In connection with thermoplastic jacket-pipes it will be possible, that changing of environment- respectively air-temperatures may cause a change of length. Therefore the bearing of the pipe clamps should be also flexible for sliding systems.

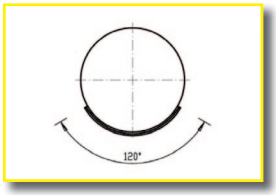
The pipe clamps has to be wide enough resp. should be equipped with a long enough bearing in order to avoid that the maximum admissible pressure load [σ_p] of the compound pipe will exceed. For PEHD- and Spiro-jacket-pipes as compound- and sliding system will be valid $\Rightarrow \sigma_p = \leq 0{,}15$ N/mm² !

In circumference direction the clamp will be effective as a pipe bearing only to a third of the circumference length. From this the effective clamp length in circumference direction [U_L] will result:

$U_L = D_a \bullet \pi : 3$ [mm]

$U_L = 250 \bullet 3{,}1416 : 3$ [mm]

Result: $U_L = 261{,}8$ mm



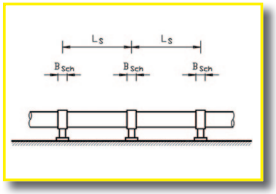
From the calculated bearing width [L_S] in m, weight force [F'_G] in N/m and circumference length [U_L] the following clamp width [B_{Sch}] will result under consideration of σ_p length direction of pipe:

$B_{Sch} = L_S \bullet F'_G : \sigma_p : U_L \bullet S_D$ [mm]

$B_{Sch} = 7{,}21 \bullet 408{,}1 : 0{,}15 : 261{,}8 \bullet 1{,}2$ [mm]

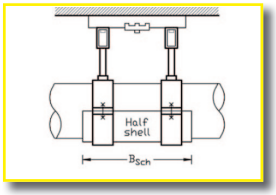
Result: $B_{Sch} = \approx 90$ mm

S_D = Safety correction value [-]



For bigger pipe dimensions a required clamp width > 200 mm can be possible. Because these clamps will be mostly not available, the required width can be distributed to a double clamp. A pipe half-shell should be put on this double clamp in order to distribute the weight. First then the **isoplus**-pipe will be layed in.

In case that the pipeline will be hanged by use of galvanized strap retainers at two spots instead of the double clamp, the installation of the half-shell will be strictly necessary. Strap retainers without pipe half-shells will damage the jacket-pipe.



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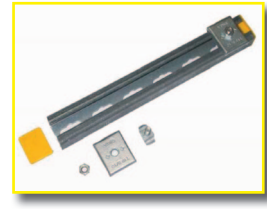
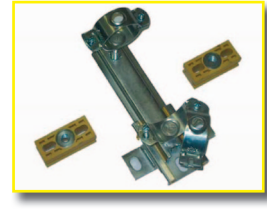
10.3.4 Support Construction



Supports can be in pendulous-hanging or sliding spandrel-braced construction. The weight- load resulting from the support distance to the pipe-shell, which will effect as tensile stress in case of hanging construction and as compressive strain in case of spandrel-braced construction, has to be considered concerning the support variations. Of course may several pipes placed over- or under each other, the load will increase accordingly.

For fixing the supports at the construction substance (concrete ceiling, trapezoidal corrugations, steel-traverse etc.) sliding carriages will be used, which are moving in sliding rails. This construction allows the compensation of the axial expansion movement of the pipeline. Complete sliding sets will be used for the area of the expansion elbows, where also the lateral expansion has to be considered. The sliding sets have to be installed at the sliding carrier, turned about 90° to the rail.

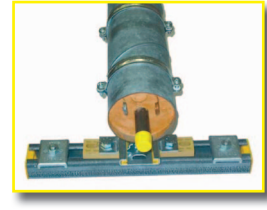


If fixed bearings- respectively fix-points should be required in consideration with the project work, it will be sufficient to fix them frictional at the jacket-pipe, in case of the compound system. Fix-points for the sliding system “high temperature pipe” have to be installed at the carrier pipe. As fixed bearings also pre-fabricated fittings, see **chapter 2.2** and **2.3,** may be used. The axial force [F_{FL}] resulting from the straight section and compensated from the fixed bearing, will be calculated per pipeline as follows:

$F_{FL} = F'_G \bullet \mu \bullet L_X$ [N]

$F_{FL} = 408{,}1 \bullet 0{,}1 \bullet 20{,}0$ [N]

Result: $F_{FL} = 816{,}2$ N



F'_G = pipe weight force [N/m]

μ = Friction number jacket pipe to support resp. clamp
⇒ Steel / Steel = 0,5 [-]
⇒ Polyethylene / Steel = 0,1 [-]

L_X = Pipeline length from fixed bearing to the next compensation spot [m]

10.4.1 Building Site - Quality Assurance

For building site it will be necessary to provide a guideline for a quality performance of the single working steps, in order to reach an optimization of the installing situation for preinsulated jacket pipes. This guideline will be valid in the same manner for civil underground engineering, pipe layer and pipe manufacturer.

Working Step	Execution and result
Pipe-bars - storage outside of the trench	- Piling of pipe bars on sand-bed or wide squared timber, which will avoid a pressing of the insulation; lateral security of pile in accordance to height
Storage of fittings	- Stored horizontal on stone-free ground and ordered to dimensions
Accessories - storage of sealing rings, couplers, expansion pads etc.	- Storage in container, or protected against weather conditions
Storage of PUR-foam and shrinking material	- Stored in ambient temperature without direct sun irradiation
Functional check and co-ordination of the tools for the relevant working steps	- Professional work can be only reached with suitable tools
Putting in place of PJP-pipes and components	- Correct transport into the trench by use of textile belts Storage on squared timber, sand sacks or PUR-foam supports; ground clearance of at least 10 cm between pipe and trench bottom or sand-bedding with head-holes.
Alignment of pipes and fittings in the trench	- Positioning of the leak detecting wires in accordance to the suppliers guideline. - Slip over the coupler at the area of the welding spot
Welding of pipes and fittings	- Considering of the instructions of the detailed estimate and the technical requirements for the later operating conditions - Mitre cuts max. 3° at sliding area and 5° at bonding area. - Weld seam test and release
Creating of working space for coupler assembling	- Bearings should be at least in a distance of 1 m from the welding seam; head-holes has to be carried out in a way that a unimpeded working procedure according to the supplier guidelines will be possible
Providing of fitting length	- Correct remove of insulation at the pipe ends of at least 150 mm without damage of the alarm wires Do not leave cold water filling in the carrier pipe.
Checking of pipeline before coupler assembling	- Temperature of carrier pipe max. 45 °C, at least more than 15 °C. - Do not cut fittings and fitting pieces too much, in order to guarantee the required coupler support. - Consider space requirement and technical practicability for the assembling fittings which will be carried out by the coupler assembler

See **isoplus**-assembling term - **chapter 11.5.2**

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