Instructions for the installation of FW STEEL-CASED PIPE-IN-PIPE

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These instructions for the installation of FW STEEL-CASED PIPE-IN-PIPE have been compiled so that the high quality standard with which FW STEEL-CASED PIPE-IN-PIPE is prefabricated can be extended to the area of installation, and also to answer frequently asked questions about the laying of this pipe system. It is essential that these instructions should be followed, otherwise any warranty claims will be void.

1 Civil engineering

1.1 Standards and guidelines

1.1.1 Standards

The execution of civil engineering work should be at least in accordance with the following standards.

DIN 1072	Highway and footpath bridges, design loads
DIN 4033	Sewers and pipelines made from prefabricated pipes, guidelines for construction
DIN 4124	Excavations and trenches, embankments, working spaces, sheeting
DIN 18300	VOB part C, General Technical Regulations - earthworks
DIN 18303	VOB part C, General Technical Regulations – building pit sheeting and cladding
DIN 18304	VOB part C, General Technical Regulations – pile driving
DIN 18305	VOB part C, General Technical Regulations – lowering of ground water
DIN 18307	VOB part C, General Technical Regulations - gas and water pipes laid in the subsoil
DIN 18308	VOB part C, General Technical Regulations – drainage works
DIN 18320	VOB part C, General Technical Regulations - landscaping
DIN 18330	VOB part C, General Technical Regulations - bricklaying
DIN 18337	VOB part C, General Technical Regulations – damp-proofing

General construction regulations, any conditions imposed by local public works departments, and when crossing railway premises, the appropriate guidelines (DVGW Memorandum W 305), are to be observed as relevant in each case. In the case of jacking, thrusting or drilling work, DVGW Memorandum GW 304 is to be observed.

This list of regulations and standards for civil engineering work does not claim to be exhaustive. Work is to be carried out in accordance with the standards in force at the relevant time and with recognised good engineering practice.

In addition, all safety regulations are to be observed.

1.1.2 Distances from other mains services

All measurements are to be taken between the outer edges of the pipes concerned.

(Source: AGFW, The Construction of District Heating Networks, 5th Edition)

Minimum distance from district heating pipelines when running parallel for a length of up to 5 m:

1 kV signal or test cables	30 cm
several 10 kV cables or one 30 kV cable	60 cm
several 30 kV cables or one cable of over 60 kV	100 cm
gas and water mains	40 cm

Minimum distance from district heating pipelines when running parallel for a length of more than 5 m:

1 kV signal or test cables	30 cm
several 10 kV cables or one 30 kV cable	70 cm
several 30 kV cables or one cable of over 60 kV	150 cm
gas and water mains	40 cm

Minimum distance of other services when crossing district heating systems:

1 kV signal or test cables	30 cm
several 10 kV cables or one 30 kV cable	60 cm
several 30 kV cables or one cable of over 60 kV	100 cm
gas and water mains	30 cm

1.1.3 Routes in public areas

When the route of the district heating pipeline runs through a public area (streets, squares etc.) the work is to be carried out in collaboration with the public authorities. This applies in particular to the erection of traffic signs.

1.1.4 Civil engineering work

The contractor carrying out the civil engineering work is not to hinder the installation of the FW STEEL-CASED PIPE-IN-PIPE system.

Spoil heaps are to be located on only one side of the pipeline route.

1.1.5 Fencing, securing of building site

Open trenches and pits are to be fenced off in accordance with the regulations (UVV Accident Prevention Regulations) and to be appropriately illuminated during hours of darkness.

1.2 Construction of the pipe trench

1.2.1 Areas of responsibility

The route plan with the trench profile for the prefabrication and installation of FW STEEL-CASED PIPE-IN-PIPE is prepared by FW-FERNWÄRME-TECHNIK GmbH.

The height plan and longitudinal sections are prepared by the planning office or the civil engineering contractor. The civil engineering contractor is responsible for conforming with and verifying the dimensions. He is to take care that any deviations or other peculiarities are recorded and later made available for the preparation of the final as-built documentation.

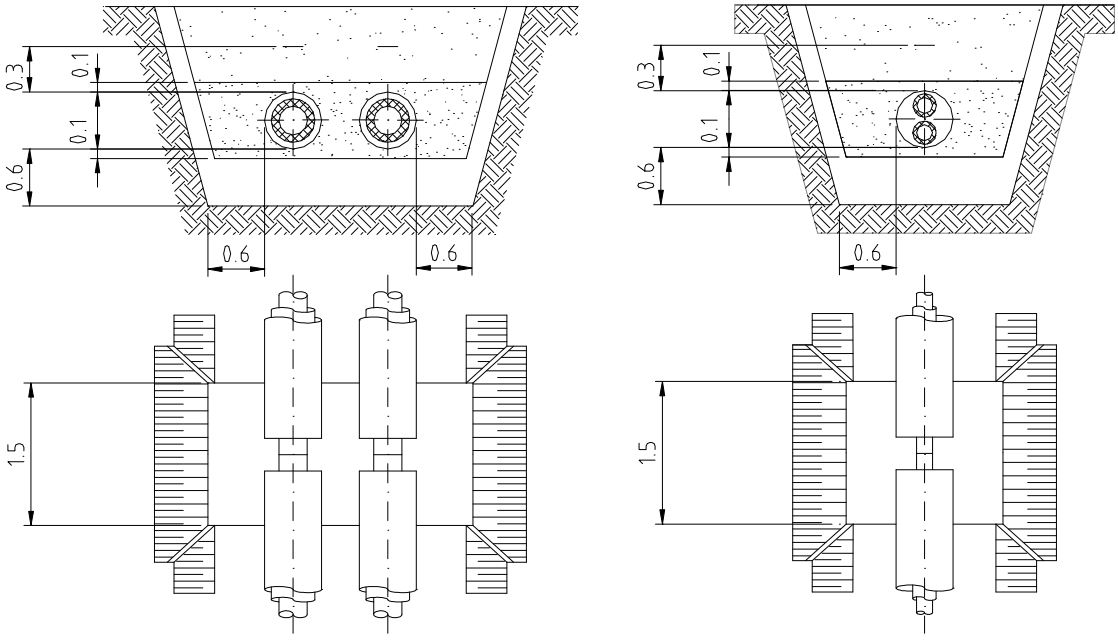
1.2.2 Field joints

For all field joints bell holes of at least the following dimensions are to be excavated:

Length: 150 cm along the axis of the pipe-in-pipe, symmetrically around the field joint

Width: 60 cm on both sides of the pipe-in-pipe

Depth: 60 cm below the bottom of the pipe-in-pipe



1.2.3 Minimum gradient of the pipeline

district heating water	1‰	(10 cm in 100 m)
steam in direction of flow	1‰	
steam against direction of flow	5 ‰	

1.2.4 Bottom of pipe trench

The bottom of the pipe trench is to be filled with a layer, at least 10 cm thick, of mechanically compacted sand (0/7 round grain), on which the FW STEEL-CASED PIPE-IN-PIPE is to rest.

The pipe trench is then to be levelled and after verification of the levelling handed over to the pipeline installation company.

1.2.5 Surface and ground water

The pipe trench and the bell holes are to be kept free of surface or ground water by the civil engineering contractor throughout the period of assembly work. The contractor is liable for any ingress of water.

1.2.6 First partial filling

When the pipe-laying and testing are completed, the pipe trench is to be filled by hand with sand (0/7 round grain) up to the level of the crown of the pipe-in-pipe and compacted.

When this first partial filling has been completed, levelling is to be carried out and verified jointly with the resident engineer and the installation firm. A log is to be kept of this process.

Care is to be taken to see that no inadmissible hollows have formed along the pipeline. If this should be found to be the case, such hollows are to be eliminated before further infilling.

1.2.7 Second partial filling

When the levelling has been completed and verified, sand (0/7 round grain) is to be filled in by hand to a level of 10 cm above the crown of the pipe-in-pipe and compacted.

1.2.8 Pipeline warning strip

The pipeline warning strip supplied by FW is to be laid 30 cm above the crown of each pipe.

1.2.9 Third partial filling

The remainder of the trench opening is to be backfilled with spoil and mechanically compacted. The Notes on the Infilling of Service Trenches in Roadways (published by Forschungsgesellschaft für das Strassenwesen e. V., Cologne, Underground Group) are to be observed.

2 Pipeline construction

2.1 Unloading and storage of FW STEEL-CASED PIPE-IN-PIPE

2.1.1 Material acceptance inspection

On arrival at the construction site, FW STEEL-CASED PIPE-IN-PIPE is to be inspected for external damage. The consignment is also to be checked for completeness. It is essential that any shortcomings should be recorded on the delivery note.

If serious shortcomings or defects are found, the project manager of FW-FERNWÄRME-TECHNIK GmbH is to be informed immediately.

2.1.2 Unloading from truck

The unloading of the truck is the responsibility of the pipe-laying firm. For the unloading the appropriate lifting gear (e.g. a mobile crane) is to be used.

The weights of the 12 m standard lengths are as shown in the following table. The weights given (in kg) are arrived at from the combination of inner and encasing pipes of the diameters used. Construction units measuring 16 m in length accordingly weigh 1.33 times more.

standard length 12 m	encasing pipe DN														
	100	150	200	250	300	350	400	500	600	700	800	900	1000	1100	1200
	114,3 x 3,6	168,3 x 4,5	219,1 x 4,5	273 x 5,0	323,9 x 5,6	355,6 x 5,6	406,4 x 6,3	508 x 6,3	610 x 6,3	711 x 7,1	813 x 8,0	914 x 10,0	1016 x 10,0	1120 x 12,5	1220 x 12,5
inner pipe DN															
25 33,7x2,6	163	283	378	525	697	779	997	1315	1664	2201	2840	3843	4418	5833	6527
50 60,3x2,9		305	400	547	719	801	1019	1337	1686	2222	2862	3865	4440	5854	6549
100 114,3x3,6			455	602	774	865	1074	1393	1741	2278	2917	3920	4496	5910	6604
150 168,3x4,5				681	853	935	1153	1471	1820	2356	2996	3999	4574	5988	6683
200 219,1x4,5					892	975	1193	1511	1860	2396	3036	4039	4614	6028	6723
250 273,0x5,0						1048	1266	1584	1933	2469	3109	4112	4687	6101	6796
300 323,9x5,6							1354	1672	2021	2557	3197	4200	4775	6189	6884
400 406,4x6,3								1805	2154	2691	3330	4333	4909	6323	7017
500 508x6,3									2212	2749	3388	4391	4967	6381	7075
600 610x6,3										2778	3417	4420	4996	6410	7104
700 711x7,1											3582	4585	5160	6575	7269
800 813x8,0												4792	5368	6782	7476
900 914x10,0													5890	7304	7999
1000 1016x10,0														7328	8023

FW STEEL-CASED PIPE-IN-PIPE is only to be lifted using textile lifting slings (minimum width 150 mm).

On the unloading of FW STEEL-CASED PIPE-IN-PIPE the insulation of the encasing pipe is to be test-examined with a 25 kV spark testing device. Any damage is to be rectified immediately.

2.1.3 Storage

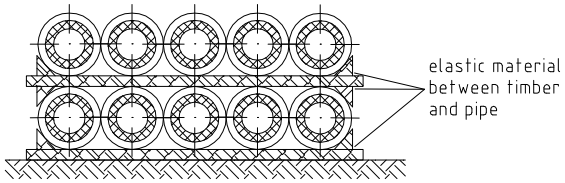
If the FW STEEL-CASED PIPE-IN-PIPE is not positioned in the pipe trenches immediately on delivery, then it should be noted that during temporary storage construction units may be stacked on top of each other only as follows:

- Pipe-in-pipe of up to DN 300 in not more than 3 tiers
- Pipe-in-pipe of over DN 300 in not more than 2 tiers
- Pipe-in-pipe of over DN 500 in not more than 1 tier

Care is to be taken that the storage site has a flat surface and is free from rubble and vegetation. The FW STEEL-CASED PIPE-IN-PIPE is to be laid upon cushioned timbers (at least 4 per construction unit). The undermost pipes may not be in contact with the ground.

In the case of construction units incorporating a wall duct, particular care is to be taken that the wall duct is not in contact with the ground and does not rest against any piece of timber.

Furthermore, care is to be taken that the “OBEN” (“TOP”) marking of each pipe is in the 12 o’clock position during storage and transport so that the pipe bearings incorporated into FW STEEL-CASED PIPE-IN-PIPE can fulfil their intended function.



The FW STEEL-CASED PIPE-IN-PIPE is to be secured against rolling away sideways.

The stacks of pipes are to be located at a sufficient distance from the pipe trench, so as not to endanger the stability of the trench walls (see 1.1.4).

If FW STEEL-CASED PIPE-IN-PIPE has to be stored for any lengthy period of time before laying, then attention must be paid to the following points:

In the case of intense sunshine, FW STEEL-CASED PIPE-IN-PIPE is to be protected by being covered with white sheeting, especially where the insulation has been finished on site (on shaped parts such as elbows and reductions).

Bituminised FW STEEL-CASED PIPE-IN-PIPE is also to be covered if there are lengthy periods of rain, so that the legibility of the writing (the labelling of the construction units) on the whitewashed surface of the bitumen does not suffer.

If exceptionally the writing inscribed on the construction units at the factory should no longer be legible, it is essential that FW-FERNWÄRME-TECHNIK GmbH should be informed.

2.1.4 Transportation caps

The transportation caps on the inner and encasing pipes or the foil packaging around the ends of the encasing pipes put on by FW-FERNWÄRME-TECHNIK GmbH may not be removed until the actual pipe installation begins. Transportation caps remain the property of FW-FERNWÄRME-TECHNIK GmbH and are to be returned when the pipes have been installed. Missing or damaged caps will be charged for.

2.2 Positioning of FW STEEL-CASED PIPE-IN-PIPE in the pipe trench

2.2.1 Testing of the encasing pipe insulation

Before the FW STEEL-CASED PIPE-IN-PIPE is positioned in the pipe trench, the insulation of the lower part of the encasing pipe is to be tested with a 25 kV spark testing device. Any damage is to be rectified immediately.

2.2.2 Markings

FW STEEL-CASED PIPE-IN-PIPE is marked as follows on the encasing pipe:

BE construction unit number (numbers in sequence)

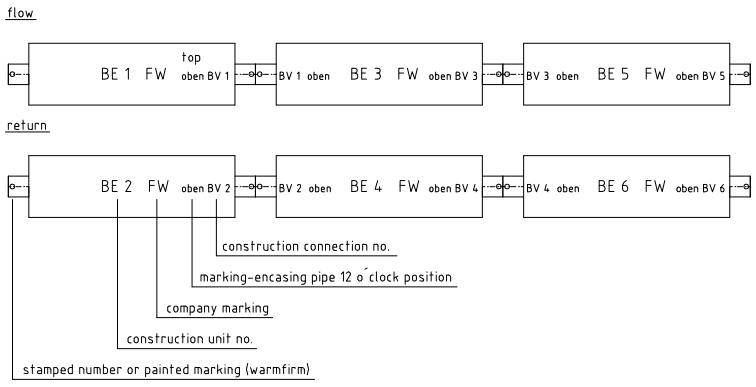
BV field joint number. Construction units that are to be joined together bear the same BV number.

Each individual construction unit is to be positioned in accordance with the FW Installation Plan.

OBEN Every encasing pipe bears the word “OBEN” (“TOP”).

O The top of every inner pipe is indicated by an O painted onto or stamped into the metal at both ends of the pipe.

When a construction unit is positioned, care is to be taken that these markings on the encasing pipe and on the inner pipe are in the 12 o’clock position.



2.2.3 Placing in the pipe trench

FW STEEL-CASED PIPE-IN-PIPE is to be placed immediately in the prescribed position on the bottom of the pipe trench.

The construction units may not be laid upon timbers.

The pipes are to be kept in position by means of sand tamped in underneath them from the sides at intervals.

Open field joints are to be protected in such a way that even in the case of a sudden inrush of water (e.g. in the event of a storm or a burst water main) no water or dirt can penetrate the inner pipe or the ring space between the inner pipe and the encasing pipe (sleeves, foil, adhesive tape).

2.3 Welding of the inner pipes

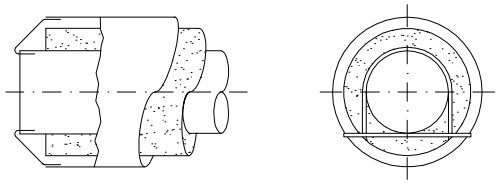
Inner pipes may only be welded by welders possessing a valid examination certificate in accordance with DIN EN 287. The recognised rules of good welding practice and the DIN standards relating to welding techniques are to be observed. The welders‘ examination certificates are to be submitted to the promoter before installation is begun.

Welding ends with a wall thickness of up to 2.9 mm are delivered without bevels; welding ends with a wall thickness over 3.2 mm are delivered with bevels according to DIN 2559, joint shape 22.

Before welding begins, the construction units are to be positioned in such a way that there is no lateral or vertical misalignment between the pipe ends that are to be welded together.

The devices securing the pipes during transportation (see drawing below) may not be removed until after the pipes have been laid in the pipe trench and the inner pipes aligned and where possible tack-welded. In the case of pipes that have to be prestressed, the securing devices are removed after the alignment of the inner pipes. It must be ensured that it is no longer possible for the pipe-in-pipe to be displaced (where necessary, the pipe run should be partially filled and the infill compacted).

At places where the inner pipe is to be prestressed, the welding of the inner pipes is to be carried out only after the prestressing (for prestressing see Section 2.4).



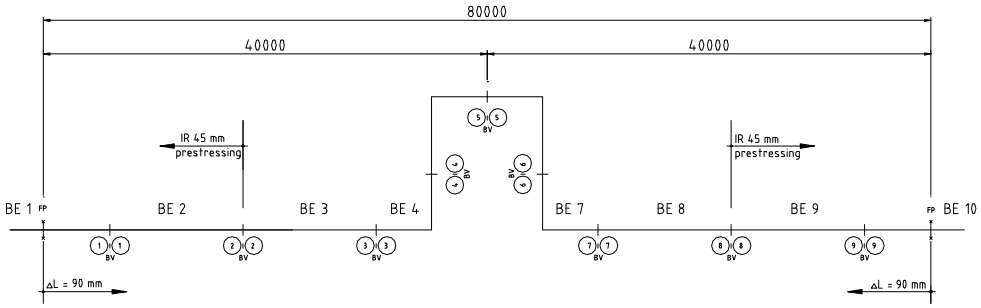
2.4 Prestressing of the inner pipes

2.4.1 Natural expansion compensators

Prestressing may not be carried out until the whole of the pipeline section, including the anchor points, has been laid and welded. Particular care must be taken to see that the encasing pipe is not displaced during prestressing. Anchor points and elbow units are to be secured against displacement. Section 2.3 (removal of the devices securing the pipes during transportation and partial infilling of the pipe run) is also to be observed.

It is absolutely essential that the prestressing values given in the FW installation plan should be complied with.

Example: Prestressing of a U-bend

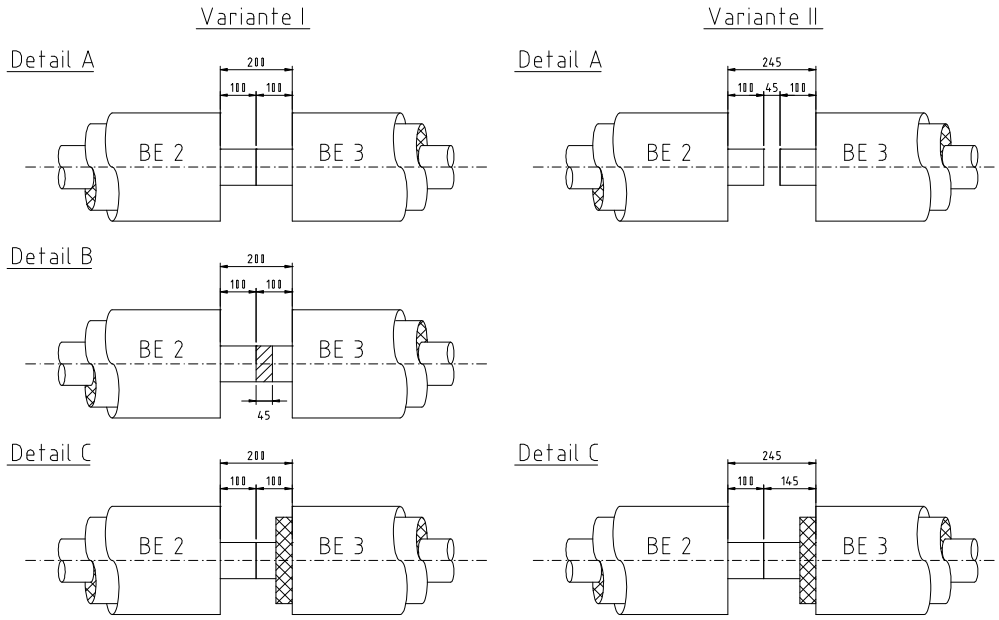


Variant I:

- weld inner pipes at all field joints (BV), except BV 2 and BV 8
- secure the encasing pipes against displacement
- remove the devices fitted to secure the inner pipes during transportation from field joints BV 2 and BV 8 (see Detail A)
- shorten the inner pipe by 45 mm at construction units BE 3 (field joint BV 2) and BE 8 (field joint BV 8) (see Detail B)
- bevel the inner pipes of construction units BE 3 and BE 8 ready for welding
- Using suitable tools, pull the inner pipe of construction unit BE 3 towards unit BE 2 and the inner pipe of construction unit BE 8 towards unit BE 9 until the root openings are of the prescribed width for welding and weld them (see Detail C). Prestressing clamps which can be obtained on loan from FW on request, are suitable for prestressing. They consist of two pairs of pipe clamps joined to each other by threaded rods.

Variant II:

There is no need to shorten the inner pipe, the construction units having already been positioned at the correct distance from each other (45 mm in the example) when they were placed in the pipe trench.



Expansion compensators in the form of elbows and Z bends are prestressed by the same procedure.

If auxiliary anchors have been mounted at the axial compensator seals at the factory (e.g. as in the case of wall ducts), these are to be inspected before and after pre-stressing to ensure the correct sitting. The positions of the auxiliary anchors must not have changed during prestressing.

2.5 Radiographic testing of inner pipe

The number of radiographic tests is generally determined by the promoter. The radiographic images are evaluated, unless otherwise specified, in accordance with DIN EN 25817, evaluation group B.

2.6 Impermeability and pressure testing of inner pipe

2.6.1 Pneumatic impermeability testing of inner pipe

If the installation procedure makes it necessary to carry out a partial impermeability test, this is to be carried out at 0.5 to max. 1.5 bars, all safety precautions being observed. In general this procedure applies to inner pipes of < DN 200.

In the case of inner pipes of > DN 200 the impermeability test is carried out using a vacuum glass.

2.6.2 Hydraulic pressure test, inner pipe

The pressure for hydraulic testing is, as a rule, 1.5 times the operating pressure, but not more than 1.3 times the nominal pressure rating. The data on testing pressure and nominal pressure rating are given on the FW route plans and must be complied with.

Unless otherwise specified by the promoter, the pressure test is to be carried out as follows:

- The pipeline is to be filled and then allowed to settle down for some 4 hours. The actual pressure test then takes place over a subsequent period of 10 hours.
- Care is to be taken that the pipeline is adequately vented during the filling and settling down processes. The testing pressure is to be monitored with a precision manometer of class 0.6 and recorded with a plotter manometer.
- A log of the pneumatic or hydraulic pressure testing of the inner pipe is to be kept jointly with the resident engineer and submitted to the promoter.
- The pressure test is to be carried out in conformity with the VdTÜV Memorandum 1051, “Hydraulic Pressure Testing of Underground Pipelines”.

Remarks on Sections 2.6.1 and 2.6.2

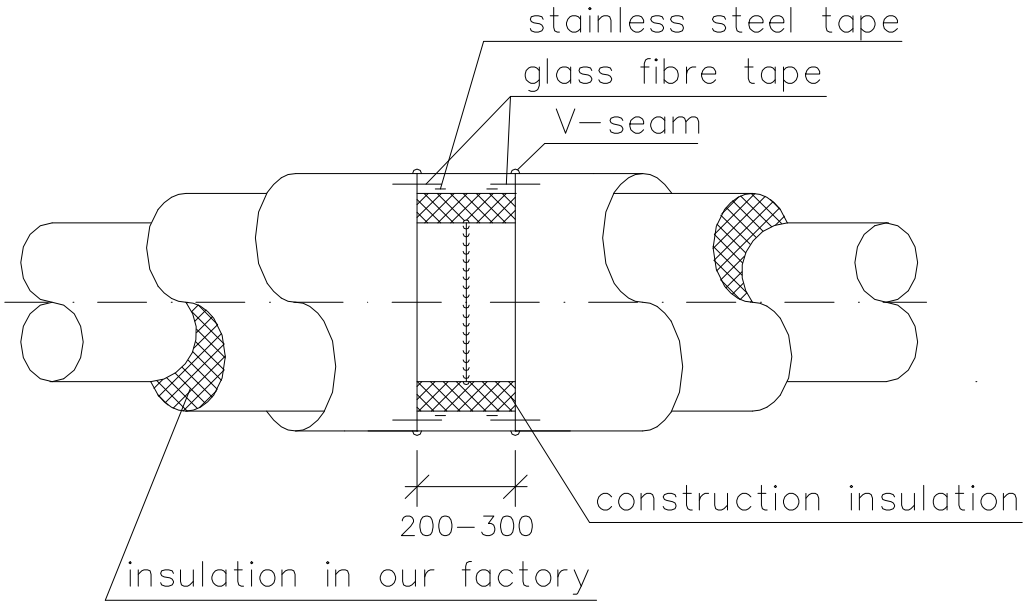
If axial compensators are incorporated into FW STEEL-CASED PIPE-IN-PIPE, then special procedural provisions for pneumatic or hydraulic pressure testing are to be observed.

2.7 Inner pipe insulation

When the radiographic testing has been completed and the pressure and impermeability testing of the inner pipes carried out, the insulation of the inner pipes is to be finished in the areas of the field joints using the lagging shell sections delivered with the units.

Care is to be taken that no gap is left between the lagging sections when fitted and insulation applied at the factory. The lagging section is to be fastened to the inner pipe by means of the two stainless steel bands per field joint delivered with it.

It is to be ensured that only lagging sections that are dry and in perfect condition are installed. In the case of operating temperatures of above 200 °C, insulation is to be effected using two layers of lagging sections with staggered joins.



As soon as the insulation of the inner pipe has been finished, this area is once again to be protected in such a way that no water or dirt can penetrate into the ring space between the inner and outer pipes or into the on-site insulation; see also Sec. 2.2.3.

Before the welding of the encasing pipe, the insulation of the inner pipe is to be protected in the vicinity of the weld by the use of the protective material (glass fabric tape) supplied.

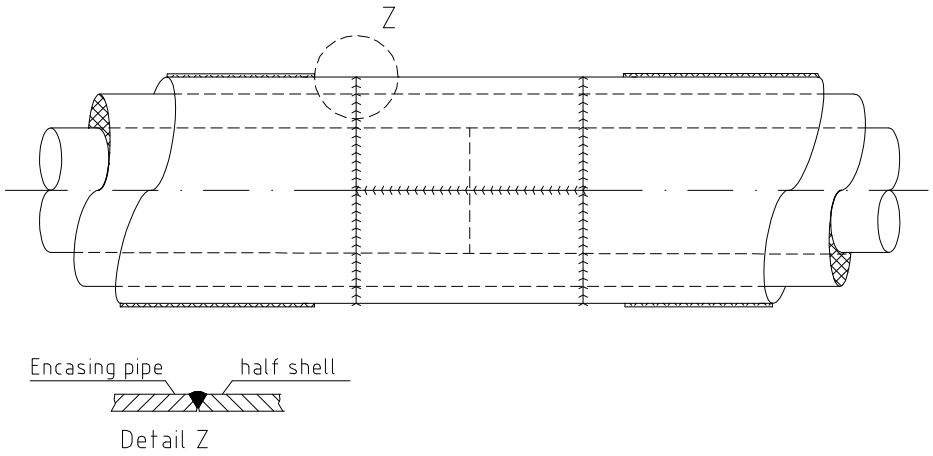
2.8 Signal cables

In the case of FW STEEL-CASED PIPE-IN-PIPE incorporating a monitoring system, the signal cables are now to be connected up at the field joints. The method of carrying out this work and measures to protect signal cables from being burnt during welding work are to be found in the separate “Instructions for the Installation of Signal Cables”, which are to be observed.

2.9 Joining encasing pipes

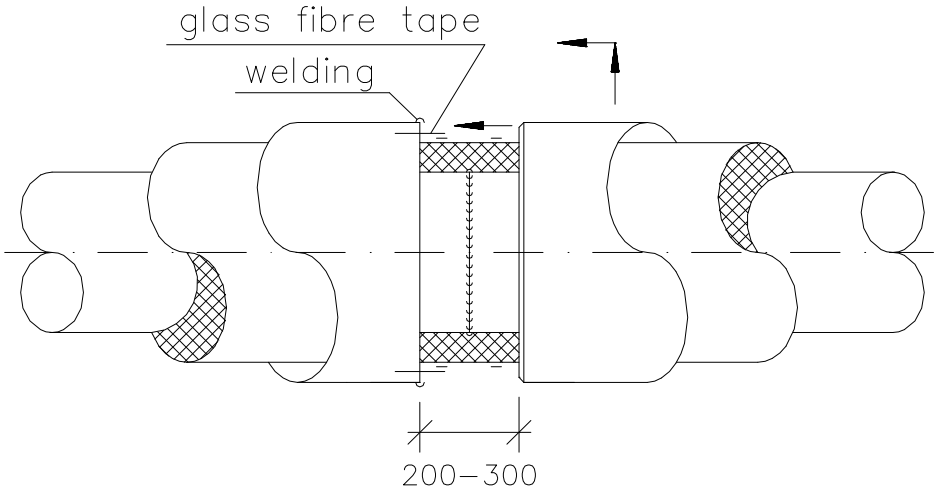
2.9.1 Joining encasing pipes with half-shells

For joints of this kind, the required length is cut from the extra section of encasing pipe provided by FW and fitted into the field joint.



2.9.2 Joining encasing pipes by pulling together the encasing pipes

When pipes are to be pulled together, one encasing pipe is lifted and pulled towards the adjacent encasing pipe. This procedure is to be carried out with extreme care. In particular, care must be taken to see that anchor points and units incorporating elbows are not displaced. Equally, construction units into which an abutment plate has been incorporated at the factory may not be pulled together.



2.9.3 Welding of the encasing pipe joints

Irrespective of the method of joining used, the following points are to be observed in the welding of encasing pipe joints:

- The insulation of the inner pipe, in particular the signal cables, are to be protected during welding work (see Section 2.7).
- Only welders disposing of a valid examination certificate as per DIN EN 287 may weld encasing pipe seams.
- Encasing pipe seams are only to be welded electrically. Welding may be performed either vertically downwards or vertically upwards.
- The edge preparation for the V-seams is to be carried out in such a way that perfect root, filler and cover passes can be achieved.
- Particular attention is to be paid to the intersection of circumferential and longitudinal seams.
- The welding of all encasing pipe seams is to be gas-tight. The welded seams are to be radiographically opaque. Radiographically inspected seams are to be evaluated, unless otherwise prescribed, in accordance with DIN EN 25817, evaluation group C.

2.10 Pneumatic impermeability test, encasing pipe

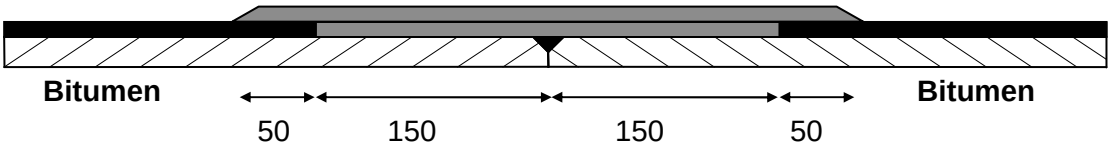
When the joining of the encasing pipe has been completed, the field joints are to be pneumatically tested for impermeability at a pressure of between 0.5 and 1 bar. A foaming soap medium is to be applied to the weld seams during this test.

The impermeability test of encasing pipes of a nominal diameter > DN 200 may be carried out by means of a vacuum glass instead.

2.11 The finishing of encasing pipe insulation

2.11.1 Finishing the insulation of bituminised encasing pipes

In the case of encasing pipes insulated with tropical quality bituminised sheathing, the insulation of the field joints is to be finished on site with the Kebu GW / HT bitumen wrappings supplied with the pipes.



Preparation

- remove all grease, oil, dirt and loose rust over a length of at least 300 mm (including insulation) from the ends of the pipes that are to be welded together
- remove the bitumen coating (sheathing applied at the factory) over a length of 150 mm
- weld the pipes; afterwards, any slag or welding beads are to be removed
- heat the non-insulated area and 100 mm of the adjacent bitumen insulation on each side to around 40℃ with a propane flame
- use a paint brush or painting roller to apply the primer supplied with the pipes (Kebusol HT primer or equivalent) thinly to the non-insulated area and to the factory sheathing on both pipes over a length of some 70 mm

1st layer of bitumen wrapping

After some 3 - 5 minutes apply the 1st layer of bitumen wrapping (Kebu GW / HT bitumen wrapping or equivalent) to the pipe while still warm.

- cut the bitumen wrapping to the appropriate length (circumference of the pipe)
- heat with a propane flame on one side until around 1 mm of the thick layer has melted to a fluid state
- lay it on the non-insulated surface, pulling it to avoid any wrinkles, and press it down well with the hand

  (If the bitumen wrapping is too narrow, several wrappings are to be used without overlap. The wrappings are to be smoothed flat at the joins with a warmed spatula.)

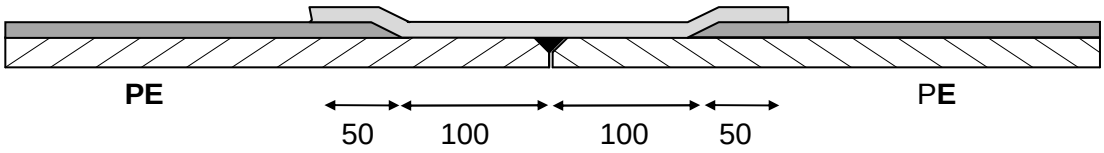
2nd layer of bitumen wrapping

Apply the 2nd layer of bitumen wrapping without delay. The bitumen sheathing applied at the factory is to be covered by the finishing sheath for a width of 50 mm on each side.

- heat the 1st layer with the propane flame until the separating agent (foil or talcum powder) has melted or been absorbed by the bitumen wrapping
- apply the wrapping in the same way as the 1st layer
- heat the edges of the wrapping again and smooth them flat with a warmed spatula

2.11.2 Finishing the insulation of PE-coated encasing pipes with shrink material

In the case of PE-coated encasing pipes, the insulation of the field joints is to be finished on site with the Canusa WLO shrink wrapping supplied with the pipes.



Preparation

- remove all grease, oil, dirt and loose rust over a length of at least 300 mm (including insulation) from the ends of the pipes that are to be welded together
- If the shrink material to be used is already in the form of a ready-to-use sleeve, this is first to be pushed over the PE-coated pipe, as it is not possible to fit it later. In this case, the PE-coated pipe must be cleaned over a length of at least 1.5 m. When mounted on the pipe, the sleeve is to be covered to protect it against welding beads and overheating.
- remove the PE coating (sheathing applied at the factory) over a length of 100 mm
- weld the pipes; afterwards, any slag or welding beads are to be removed
- heat the non-insulated area and 100 mm of the adjacent PE insulation on each side to around 40℃ with a propane flame
- roughen the PE-coated pipes with coarse abrasive paper over a length of 200 mm

Shrink sleeve / shrink wrapping

a) Processing of the prefabricated shrink sleeves:

- heat the area to be insulated to around 60℃ with a propane flame over a width of 400 mm
- remove the protective foil from the shrink sleeve
- push the shrink sleeve over the area to be insulated and centre it over the area
- Heat the shrink sleeve from the centre outwards radially and regularly, in order to expel any air or moisture sideways. The yellow inscription will turn orange at the right temperature. The shrinking process is completed when the entire shrink sleeve lies smooth on the pipe without bubbles.

b) Processing of the Canusa WLO shrink wrapping (from the roll):

- heat the area to be insulated to around 60℃ with a propane flame over a width of 400 mm
- cut the wrapping from the roll, allow for an overlap of around 100 mm on the circumference of the pipe
- remove the protective foil from the shrink sleeve
- warm the shrink wrapping slightly and lay it around the pipe
- remove the protective foil from the sealing tape CLS - ....
- Heat the sealing tape on the coated side, lay it centrally on the join of the overlap and weld it carefully with the propane flame. Press the sealing tape down repeatedly with the hand. In this way, a sleeve is formed.
- Heat the shrink sleeve from the centre outwards radially and regularly, in order to expel any air or moisture sideways. The yellow inscription will turn orange at the right temperature. The shrinking process is completed when the entire shrink sleeve lies smooth on the pipe without bubbles.

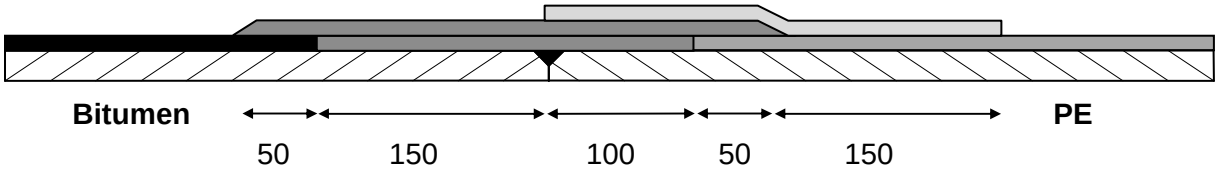
- **Inspection of the shrink sleeve**

  The sleeve must lie on the pipe smoothly and be free of bubbles all round.

  The fusion adhesive must have been pressed out sideways onto the PE insulation round the whole circumference of the pipe; there must be an overlap of at least 50 mm on the PE insulation.

2.11.3 Finishing the insulation at a bitumen/PE transition

The insulation at a bitumen/PE transition is to be finished as follows:



Preparation

- remove all grease, oil, dirt and loose rust over a length of at least 300 mm (including insulation) from the ends of the pipes that are to be welded together
- If the shrink material to be used is already in the form of a ready-to-use sleeve, this is first to be pushed over the PE-coated pipe, as it is not possible to fit it later. In this case, the PE-coated pipe must be cleaned over a length of at least 1.5 m. When mounted on the pipe, the sleeve is to be covered to protect it against welding beads and overheating.
- the bitumen coating is to be removed over a length of 150 mm, the PE coating over a length of 100 mm
- weld the pipes; afterwards, any slag or welding beads are to be removed
- heat the non-insulated area and 100 mm of the adjacent bitumen and PE insulation on their respective sides to around 40℃ with a propan e flame
- roughen the PE-coated pipes with coarse abrasive paper over a length of 200 mm
- use a paint brush or painting roller to apply the primer supplied with the pipes (Kebusol HT primer or equivalent) thinly to the non-insulated area and to the factory sheathing on both pipes over a length of some 70 mm

1st layer of bitumen wrapping

After some 3 - 5 minutes apply the 1. layer of bitumen wrapping (Kebu GW / HT bitumen wrapping or equivalent) to the pipe while still warm.

- cut the bitumen wrapping to the appropriate length (circumference of the pipe)
- heat with a propane flame on one side until around 1 mm of the thick layer has melted to a fluid state
- lay it on the non-insulated surface, pulling it to avoid any wrinkles, and press it down well with the hand

(If the bitumen wrapping is too narrow, several wrappings are to be used without overlap. The wrappings are to be smoothed flat at the joins with a warmed spatula.)

2nd layer of bitumen wrapping

Apply the 2nd layer of bitumen wrapping without delay. The PE and bitumen sheathing applied at the factory is to be covered by the finishing sheath for a width of 50 mm on each side.

- heat the 1st layer with the propane flame until the separating agent (foil or talcum powder) has melted or been absorbed by the bitumen wrapping
- apply the wrapping in the same way as the 1st layer
- heat the edges of the wrapping again and smooth them flat with a warmed spatula

Shrink sleeve / shrink wrapping

a) Processing of the prefabricated shrink sleeves:

- heat the area to be insulated (transition between PE factory sheathing and 2nd layer of bitumen wrap) with a propane flame over a width of 400 mm:
  - PE factory sheathing to around 60℃
  - 2nd layer of bitumen wrapping to around 50℃
- remove the protective foil from the shrink sleeve
- push the shrink sleeve over the transition between PE factory sheathing and 2nd layer of bitumen wrapping and centre it over the join
- Heat the shrink sleeve from the centre outwards radially and regularly, in order to press out any air or moisture sideways. The yellow inscription will turn orange at the right temperature. The shrinking process is completed when the entire shrink sleeve lies smoothly on the pipe without bubbles. Particular care must be taken when working on the bitumen-insulated side, in order to prevent the bitumen from dripping off and thus unacceptably reducing the thickness of the layer.

b) Processing of the Canusa WLO shrink wrapping (from the roll):

- heat the area to be insulated (transition between PE factory sheathing and 2nd layer of bitumen wrapping) to around 60℃ with a propane fla me over a width of 400 mm:
  - PE factory sheathing to around 70℃
  - 2nd layer of bitumen wrapping to around 55℃
- cut the wrapping from the roll, allow for an overlap of around 100 mm on the circumference of the pipe
- remove the protective foil from the shrink sleeve
- warm the shrink wrapping slightly and lay it around the pipe
- remove the protective foil from the sealing tape CLS - ....
- Heat the sealing tape on the coated side, lay it centrally on the join of the overlap and weld it carefully with the propane flame. Press the sealing tape down repeatedly with the hand. In this way, a sleeve is formed.
- Heat the shrink sleeve from the centre outwards radially and regularly, in order to expel any air or moisture sideways. The yellow inscription will turn orange at the right temperature. The shrinking process is completed when the entire shrink sleeve lies smoothly on the pipe without bubbles.

- **Inspection of the shrink sleeve**

  The sleeve must lie on the pipe smoothly and be free of bubbles all round.

  The fusion adhesive must have been pressed out sideways onto the PE insulation round the whole circumference of the pipe; there must be an overlap of at least 50 mm on the PE insulation.

2.11.4 Finishing the insulation with anti-corrosion wrappings

Finishing with DENSOLEN S 40 tape is particularly suitable to provide corrosion protection at elbows and junctions, as it adapts well to the surface.

Preparation

- remove grease, oil, dirt and loose rust from the ends of the pipes that are to be welded
- paint the metal surface and the adjacent factory sheathing with DENSOLEN HT primer over a distance of 75 mm on each side
- allow the HT primer to dry for around 5-10 minutes, depending on air temperature and wind conditions

Inner wrapping

- Wind the DENSOLEN S 40 tape spirally around the pipe with the grey side towards the metal, keeping it pulled tight all the time and with at least 50% overlap. The separator layer is to be removed. The factory sheathing is to be covered by the wrapping for a length of 50 mm on each side.

Outer wrapping

- repeat the same process as for the inner wrapping, but with an overlap of only 10 to 20 mm

Alternative for straight pipes from DN 250 upwards

- With the assistance of a special winding machine it is possible to wrap the pipe in anti-corrosion wrapping in a single step, with 67% overlap. For this, DENSOLEN tape with a width of 100 mm is required. The factory sheathing is then covered by the wrapping for a length of 100 mm on each side.

2.12 Testing the insulation of the encasing pipe

Shortly before the infilling of the pipe trench the coating of the encasing pipe including that of the field joints is to be tested for non-porosity and integrity with a spark testing device (25 kV). Any defective points are to be repaired.

A log of the testing of the encasing pipe insulation is to be kept jointly with the resident engineer and submitted to the promoter.

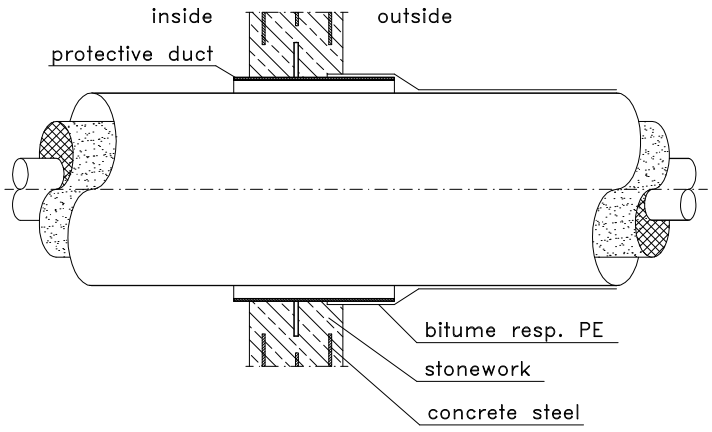
3 Special construction elements

3.1 Wall ducts

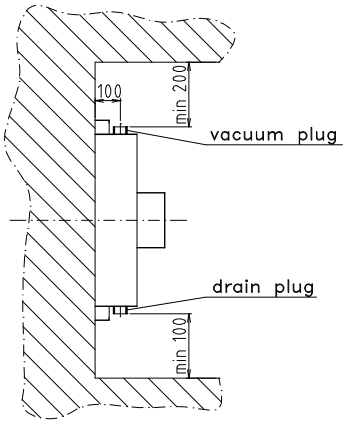
Wall ducts where the sheathing pipes are coated with Prodoral EW 99 (a two-component plastic on an epoxy resin base) are to be tested before and after installation in the wall openings with a spark testing device (5kV). Any damage is to be repaired using Prodoral EW 99, and the spark test is then to be repeated. Care must further be taken that there is no electrically conductive contact between concrete reinforcing steel and coated wall ducts.

If wall ducts are fitted with lenticular compensators, these must be cushioned on site with non-perishable material.

Wall opening:



The encasing pipe drainage and vacuum glands must be freely accessible



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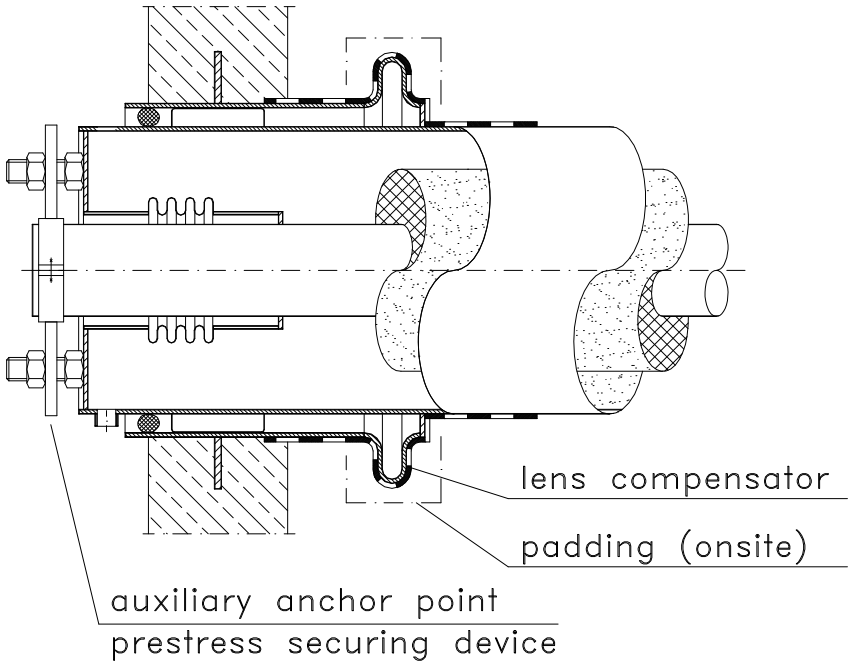
3.2 Axial compensators in FW STEEL-CASED PIPE-IN-PIPE

If axial compensators have been installed in FW STEEL-CASED PIPE-IN-PIPE construction units at the factory, they will in general have already been prestressed at the factory and fitted with a securing device. This prestress securing device consists of a pipe clamp that is screwed on to the inner pipe and which has steel plates welded to it to form a connection with the encasing pipe. This securing device may not be removed until the inner and encasing pipes have been connected to an anchor under stress.

3.3 Axial compensator end seals

End seals of the vacuum-tight variety contain axial compensators as elastic sealing elements. Where required, these compensators are prestressed at the factory. The prestress securing device may not be removed until after the inner pipes have been joined together under stress. This also involves the inner pipes having already been prestressed at the prescribed places.



3.4 Angular and lateral compensators

When angular and lateral compensators are to be installed, the special instructions given by FW-FERNWÄRME-TECHNIK GmbH are to be observed. These instructions vary from project to project.

When carrying out pressure tests, it is vital that the special installation instructions of the compensator manufacturer concerned and of FW-FERNWÄRME-TECHNIK GmbH should be observed. In particular, the inner pipe must be welded as far as the anchors on each side of the compensator and the anchors must be secured against displacement.

3.5 FW STEEL INSPECTION CHAMBERS

When installing FW STEEL INSPECTION CHAMBERS, attention must be paid to the following points:

- A compacted sand cushion (0/7 grain), at least 15 cm thick, is to be prepared in the chamber pit.
- When installing steel inspection chambers at groundwater level, it is necessary to take additional precautions against the chambers lifting. This may take the form of an additional ring of concrete around the lower part of the body of the chamber, in which case it should be noted that a layer of polystyrene, about 15 mm thick, is to be inserted between the concrete and the bituminised surface. The masses of the concrete are prescribed by FW-FERNWÄRME-TECHNIK GmbH.
- Before the chamber is sunk, the external bitumen insulation is to be tested for integrity using a 25 kV spark testing device. Any damage is to be rectified immediately.
- The jack rings mounted on the chamber cover for transportation purposes are to be removed once the chamber has been sunk into the pit. The resulting gaps in the bitumen insulation are to be closed by the application of two layers of bitumen and tested at 25 kV.
- The connecting pieces for the ventilation and evacuation tubes, which are supplied loose with the inspection chamber, are to be welded onto the body of the chamber directly after the positioning of the chamber in the pit, thus preventing any inadvertent ingress of water into the chamber. The weld is also to be insulated by the application of two layers of bitumen and tested at 25 kV.
- The access shaft is adjustable in height by means of a fitting piece 0.5 m long. The shaft is to be adjusted on site to the height required and welded to the chamber cover. The weld is to be insulated by the application of two layers of bitumen.
- If lenticular compensators are fitted to chamber penetrations, they must be cushioned on site.
- Directly before the infilling of the pit the bitumen insulation is to be tested for non-porosity with a 25 kV spark testing device. Any defective points are to be repaired.
- The pit is to be refilled with sand layer by layer. Each layer is to be properly compacted, in order to avoid any shearing stress on the pipe connections.

4 Alterations and commissioning

4.1 Alterations

Any deviations from the installation plan that are found to be necessary when laying FW STEEL-CASED PIPE-IN-PIPE must be approved in advance by FW-FERNWÄRME-TECHNIK GmbH. Any alterations must be documented and the documents made available to FW-FERNWÄRME-TECHNIK GmbH for use in the compilation of the final as-built documentation.

4.2 Commissioning

The pipeline may not be taken into service until the installation work has been completed and the pipe trench completely filled in.

Before commissioning, the ring space is to be evacuated to an absolute pressure of 1 mbar by an evacuation fitter of FW-FERNWÄRME-TECHNIK GmbH. To shorten the evacuation time, the inner pipe should be heated from time to time to a low temperature (approx. 100℃). The FW evacuation fitter will properly seal all glands and will prepare an evacuation log giving details of the measurement of the pressure rise. This log is to be signed by the promoter. The leakage rate may not exceed the level recommended as acceptable in the AGFW Regulations.

The pipeline may not be taken into service without evacuation except with the express approval of FW-FERNWÄRME-TECHNIK GmbH. In this case, it may be necessary for the manufacturer to limit the maximum permissible operating temperature. Care must then be taken to see that the encasing pipe drainage glands at the end seals are opened in order to allow evaporated moisture to escape. If there should be any indication that water is collecting in the ring space, it is essential that this water should be removed immediately.

The operating parameters given on the FW route plans may not be exceeded.

Commissioning is to be carried out in accordance with recognised good engineering practice.

4.3 Subsequent evacuation

The pressure in the ring space of the FW STEEL-CASED PIPE-IN-PIPE is to be checked at regular intervals (at least once a year). If there is a slight increase in pressure (100 mbars), it lies within the discretion of the operator whether the ring space should be evacuated again in order to reduce the heat loss. If there is a marked rise in pressure (500 mbars), the manufacturer should be consulted immediately.

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