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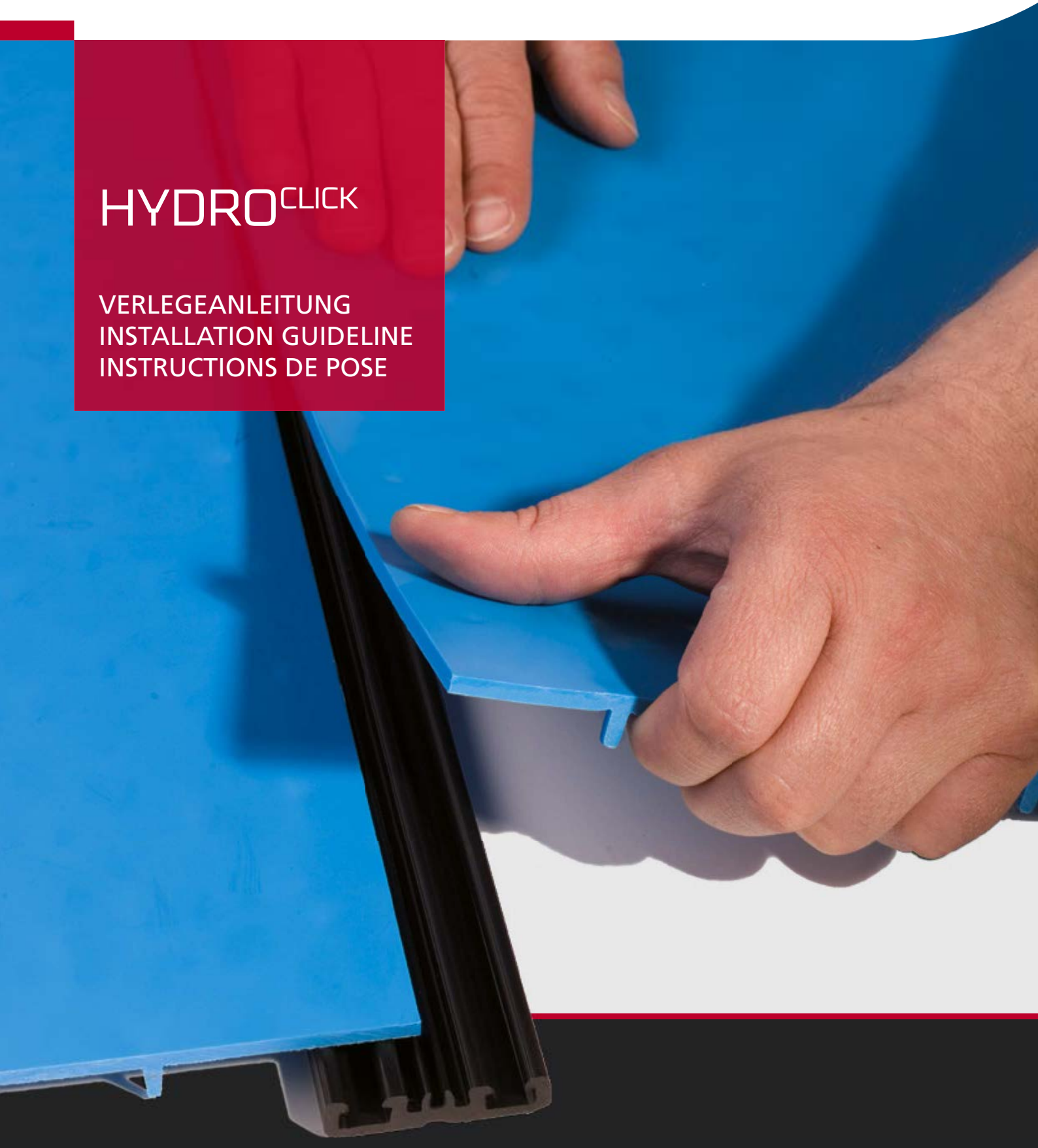
HYDRO CLICK

VERLEGEANLEITUNG
INSTALLATION GUIDELINE
INSTRUCTIONS DE POSE



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Content

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1 Introduction

For more than 40 years, pipes made of PE used for the transport and distribution of potable water has been employed to ensure the potable water quality. According to the actual standardization a service life of >100 years for PE pipe products can be considered.

The pure storage of water is a very important criteria for the supply guarantee. Up to now, storage tanks, usually steel concrete basins, have been coated with adhesive lining systems, e.g. epoxy, tiles or only mineral coating. As there appear problems at the repair with moist undergrounds resp. regarding the resistance of linings against carbonic acid but also at very soft water, many water boards searched for alternatives.

The requirement on such linings in the potable water area includes the following issues in addition to the demands on a fast installation without expensive preparation resp. remove of the existing lining:

- corrosion resistance
- resistant against chlorination (up to 3 mg/l*)
- long life expectancy (>50 years)
- complete leak control
- high surface quality, no deposits
- easy to maintain and suitable for high pressure cleaning
- resistant against micro-organic corrosion

The development of the HYDROCLICK system is cooperation with the Swiss company Etertub AG has considered these requirements resulting in a system solution which covers these features. The drain space between the liner and the wall ensures that no condensation will further deteriorate the concrete and provides also corrosion protection for the concrete structure.

* for short term, permanent maximum for chlorination is 0,5 ppm free chlorine resp. 0,3 ppm ClO2

2 System description

The HYDROCLICK system has been used as lining system in new consturction and renovation of potable water storage tank.

2.1 Material

The liners made of PE 80 blue which is also used for potable water piping systems. The material is specially developed for the use at potable water applications and is processed on state-of-the-art extruders.

2.2 Physical features

Internal production regulations, internal control and tests are done acc. to DIN EN ISO 14632-extruded sheets out of Polyethylene (HDPE). Important physical features of the HYDROCLICK sheets are stated in the tabel below.

Property	Standard	Unit	Guide Value
Nominal Thickness	DIN EN ISO 14632	%	±5
Density (blue; RAL 5012)	ISO 1183	g/cm³	>0,943
MFR melt flow rate (190 °C / 5 kg)	ISO 1133/18	g/10 min	0,9
Heat Reversion (110 °C / 1,0 h)	DIN EN ISO 14632	%	≤3
Tensile strenght at yield	DIN EN ISO 527	N/mm²	≥15
Elongation at yield	DIN EN ISO 527	%	≥8
Elongation at break	DIN EN ISO 527	%	≥300
Puncture resistance	ON EN ISO 6603-2	N	≥4500

Table 1: Physical guide values

2.3 HYDROCLICK-Liner

HYDROCLICK-Liners are produced with a special extrusion technology using a sheet die with affiliated calander in a continuous process. This special production technology provides distance and click studs which are created in one process and need not to be welded or formed afterwards. A protective film with perforated margin is placed on the smooth side of the liner which avoids scratches and contamination during the installation

HYDRO^{CLICK}-Liners have a wall thickness of 4 mm and are available in different dimensions (see table below).

Delivery	Dimension	Width	Lenght	Weight	Diameter
	[mm]	[m]	[m]	[kg/m²]	[mm]
Roll	4	2.0	50	4.4	~960
Sheet	4	2.0	4.0	4.4	-

Table 2: Delivery HYDRO^{CLICK}-Liner

The high quantity of distance studs (approx. 1400 pcs/m²) and their special design with a height of 9 mm guarantees a defined distance between the concrete and the HYDRO^{CLICK} liner.

Click studs are positioned in one row at the margin and in two rows in the middle area of the sheets. Total width can varii up to a minus tolerance of 20 mm below the nominal of 2000 mm. The reason for this is that the distance from click stud edges are defined and variations fo materials must be considered for production technique by extrusion calandering.

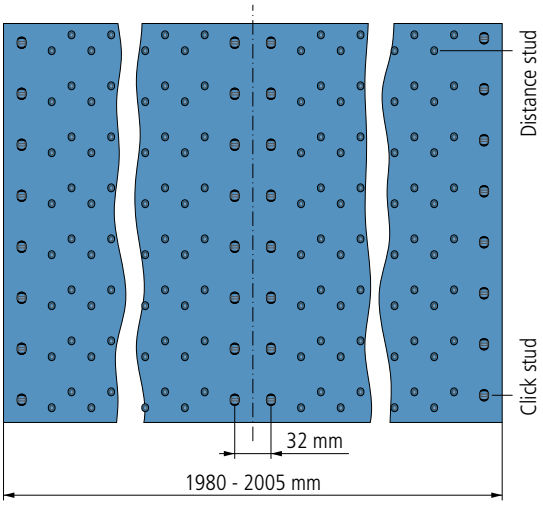


Figure 1: Stud order. Click studs centered (2 rows) and marginal (1 row).

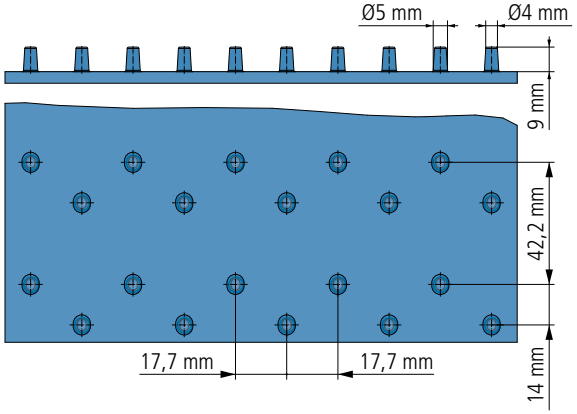


Figure 2: Detail edge zone

2.4 HYDRO^{CLICK}-Profil

The HYDRO^{CLICK}-profiles are extruded in a standard length of 4 m and supplied in a film tube with 10 pcs. each. Special length are available on request.

The HYDRO^{CLICK} profile is manufactured by extrusion with a co-extruded HDPE-el (electro conductive) indicator which is centrally positioned.

The material is PE 80, adjusted to the system. Special profiles with one-side click nut are available on request.

2.5 Welding rod acc. to DVS 2211

Round welding rod (3 mm and 4 mm circular profile) made of PE 80 blue is used. The welding rod is provided on coils (approx. 3 kg/ coil) in a box (2 rolls each).

2.6 Extruded semi-finished sheets

Extruded sheets out of PE 80 blue in 4 x 2 m are available from stock in 5 mm - 20 mm thickness. These sheets are manufactured acc. to DIN EN ISO 14632.

2.7 Quality assurance

The internal control of HYDRO^{CLICK} sheets is done according to DIN/ ON ISO 14632 sheet group 2. The quality assurance is provided by a test certificate 2.2 according to ÖNORM/EN 10204:2005.

2.8 Packaging, transport and storage

After internal quality assurance HYDRO[CLICK] sheets are cut or standard prepared roll on a thermoplastic coil (od 180 mm; id 150 mm) with a length of 50 m. Rolled liners are prepared and piled with a protective film and edge guards. Sheets are piled on solid wooden pallets.

Sheets should be handeled so that onesided loads on edges or corners which could result in deformations or damages are avoided.

The complete installation material has to be transported, stored and installed with care.

Of particular note is that the surface of the sheets is not damaged or scratched.

For reloading on site suiting mandrel pilers resp. lifting devices for sheets have to be provided (minimum 2,0 m long mandrel or fork).

The sheets/ rolls should be protected against sun radiation in order to avoid heating and linear expansions of the material. Rolls must be stored on a clean underground wihtout stones and the pile height need not be higher than 2 rows.

NOTICE!
Before installation, cut sheets have to be conditioned in the tank to be lined.

Temperature changes have to be considered at the preparation of the sheet lengths by including additional lengths. The perfect suiting length is adjusted on the wall or ground.

3 Processing

3.1 Machining

Machining is performed with equipments which are used in the timber industry. The following guideline is the basis for machining: VDI 2003 MACHINING of thermoplastics.

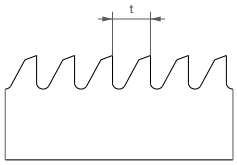
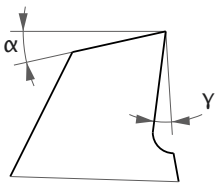
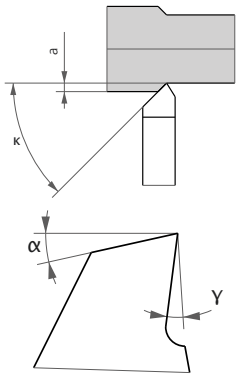
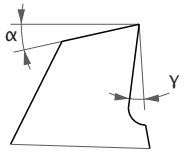
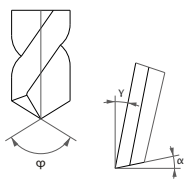
CUTTING				
	Clearance angle α	[°]	30 - 40* 10 - 15**	Band saws are appropriate for the cutting of pipes, blocks, thick sheets and for round parts.
	Rake angle γ	[°]	0 - 8	
	Pitch t	[mm]	2 - 8	
	Cutting speed v	[m/min]	bis 3000	
CUTTING				
	Clearance angle α	[°]	30 - 40* 10 - 15**	Circular saws can be used for the cutting of pipes, blocks and sheets. HM saws have a considerably longer working life.
	Rake angle γ	[°]	5 - 8* 0 - 5**	
	Pitch t	[mm]	2 - 8	
	Cutting speed v	[m/min]	-	
TURNING				
	Clearance angle α	[°]	5 - 15	The peak radius (r) should be at least 0,5 mm. High surface quality is obtained by means of a cutting tool with a wide finishing blade. **Cut-off:** Sharpen turning tool like a knife.
	Rake angle γ	[°]	0 - 10	
	Tool angle κ	[°]	45 - 60	
	Cutting speed v	[m/min]	200 - 500	
	Feed s	[mm/U]	0,1 - 0,5	
	Cutting depth a	[mm]	up to 6	
	Peak radius r	[mm]	min. 0,5	
MILLING				
	Clearance angle α	[°]	5 - 15	High surface quality is obtained by eans of a milling machine with fewer blade-this increases cutting capacity.
	Rake angle γ	[°]	up to 15	
	Cutting speed υ	[m/min]	up to 1000	
	Feed s	[mm/U]	up to 0,5	
	Cutting depth a	[mm]	-	
DRILLING				
	Clearance angle α	[°]	10 - 12	Spiral angles 12 - 16°. For holes with diameters of 40 - 150 mm, hollow drills should be used; for holes < 40 mm diameter, use a normal SS-twist drill.
	Rake angle γ	[°]	3 - 5	
	Centre angle φ	[°]	60 - 90	
	Cutting speed v	[m/min]	50 - 100	
	Feed s	[mm/U]	0,2 - 0,5	
	Spiral angle β	[°]	12 - 16	

Table 3: Processing variation overview

* high speed steel values
** hard metal values

3.2 Process of assembling

The components for large projects ar prepared directly ex works AGRU Kunststofftechnik GmbH as sheets or rolls. The preparation for smaller constructions is done by the installers using rolls. Sections can be elongated by heated element butt welding at AGRU or by extrusion welding on site.

Click profiles do not demand a preparation. The individual profils are sized and welded by butt fusion or conected without welding.

Distance or click studs are removed by a router and distance sliding carriage. Also a chisel can be used for manual works but it has to be considered that the ground base is not damaged.

4 Installation

4.1 General notes

HYDRO^{CLICK}-sheets are delivered with a standard protective film. The protective film is perforated approx. 5 cm on each side. The double - sided strips can be removed after installation and the welding procedure can start. After the works are finished, the complete film can be removed. It is recommended to use a 1 mm FPO protective liner in the immediate working area to prevent damage to the surface by falling tolls.

Figure 3: HYDRO^{CLICK} with protective film

Figure 4: Removement of the protective film at the welding area

Dust appearing during the drilling work hast to be continuously removed by a vacuum cleaner. The positioning of the HYDRO-^{CLICK} liners on site is done according to an installation plan under supervision of trained personel or an authorized fabricator who has to do the welding afterwards. The exact ordering of joints, the kind of joints and marking have to be indicated in the installation plan.

4.2 Installation procedure

4.2.1 Installation examples

The principle sketches below illustrate the essential installation steps and examples of details for the HYDRO^{CLICK} lining systems:

- Wall lining
- Floor lining
- Corners and wall installation
- Floor-wall sections
- Sheet installation without click stud or one side
- Sump lining
- Lining of pillars
- Pipe penetrations
- Connecting walls
- Mounting anchor fixations
- Pressure tight door

4.2.2 Thermoforming

Corners should be performed with thermoformed profiles out of HYDRO^{CLICK} sheets with a distance of maximum 50 cm between leg and click profile.

Corners or pillars are mainly lined by thermoforming. Tolerances of angles and measurements can be compensated with this installation technology. In addition the welding joints are positioned to the straight butt fusion area which results in a minimized quantity of pieces and on easier installtion. The heating up of the sheets for thermoforming can be done with hot gas, a heating element or contactless by infrared radiation. Undefined heating up with a flame is not allowed.

4.2.3 Drainage

It has to be considered that the water flow behind the sheet is not hindered by the installation of the click profile. In case of water influence from the ground corresponding measures acc. to DIN 18195 - 4 to 18195 - 6 have to be set.

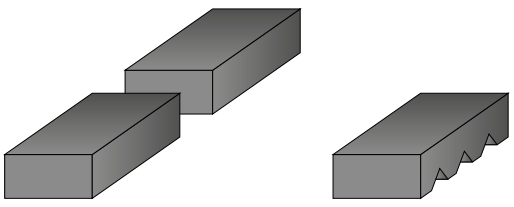


Figure 5: Drainage strips and profiles

4.2.4 Wall lining

It is recommended to install the wall sealing first.

The installation of HYDROCLICK sheets on the wall is one-sided placed in advance. The sheets are lifted and clicked onto the already installed click profile. The fixation of the click profiles follows and the installation precedure is repeated till the complete wall area is lined (see installation example). The lifting of the sheets guarantees a complete fit on the concrete surface and avoids any waves of the liner.

The anchoring distance of the click profile is between 400 and 800 mm according to the condition of the stonework. Flat head screws out of stainless steel (min. A2/A4) are used. The anchoring depth corresponding to the conditon of the stonework.

If the installation in joint areas has to be done without click studs, wheter a strip out of PE 80 with 10 mm thickness and 50 mm width or a one-side click nut milled profile is used.

In non-clickable areas the HYDROCLICK sheets are tackwelded on the profiles with a gap of approx. 6 mm - 10 mm. A linear thermal connection with the profile is created by extrusion welding.

It has to be considered that the choice of fixation material and also the fixation distance (approx. 400 mm) is adjusted to the conditon of the concrete.

Optimized extrusion joint acc. to DVS 2207 - 4.

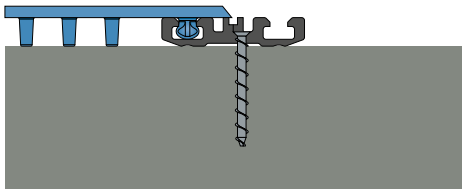


Figure 6: Step 1

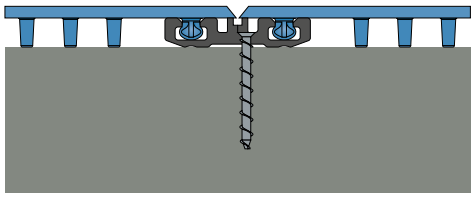


Figure 7: Step 2

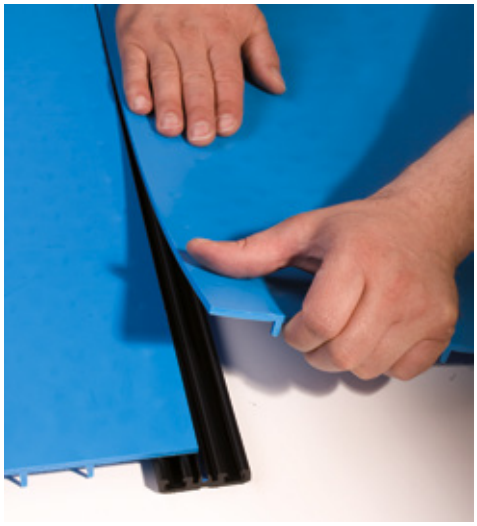


Figure 8: Step 2 - click in

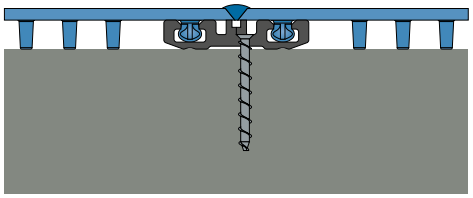


Figure 9: Step 3

Figure 10: Extrusion welding

Figure 11: Welding seam.

4.2.5 Floor lining

The installation steps of the floor area are basically the same as of the wall area. It has to be considered that the installation of click profiles is done in flow direction of the pump sump. Interruptions for the water flow to the pump sump have to be set crosswise to the profile (see chapter 4.2.9).

Optimized extrusion joint to DVS 2207 - 4.

4.2.6 Corners and wall installation

In corner areas the HYDRO^{CLICK} sheet should be fixed to PE strips (tackwelding) so that the movement of sheets and the creation of waves in the corner section is avoided or the distance between legs and first click profile should be reduced to 0,5 m.

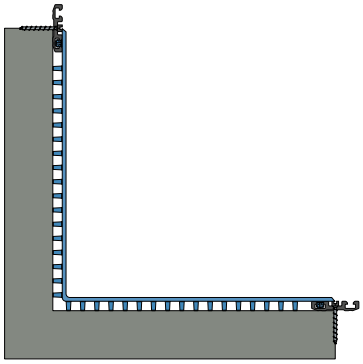


Figure 12: Preformed corner

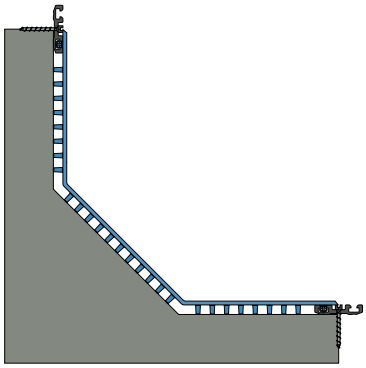


Figure 13: Preformed corner

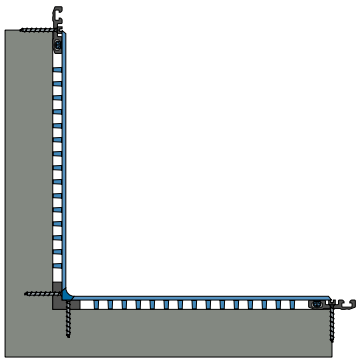


Figure 14: Corner extrusion welded

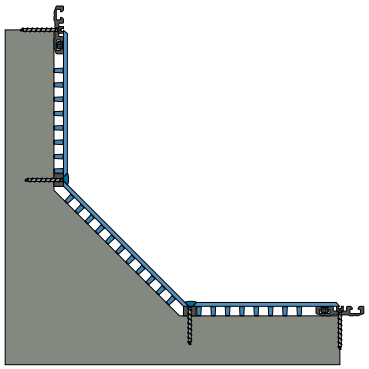


Figure 15: Corner extrusion welded

4.2.7 Floor-wall section

Tackwedling of the floor-wall section is absolutely necessary before the extrusion welding of the sheets is done. If needed the extrusion welding has to be performed by using support profiles. It has to be considered that the support profiles ensure a continuous drainage. (e.g. distance between profiles or indentation of the profiles)

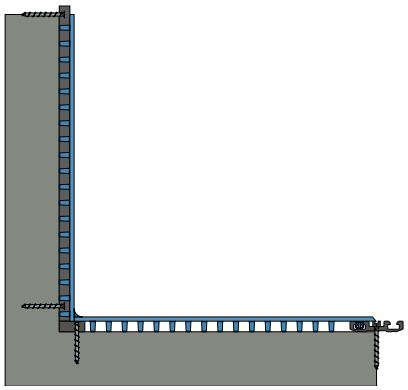


Figure 16: Transision extrusion welded.

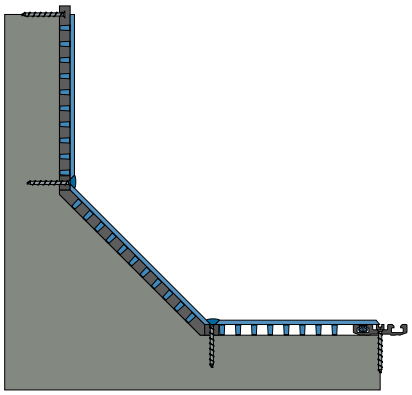


Figure 17: Transision extrusion welded

4.2.8 Construction at non-clickable areas

Transitions where click is not possible can be executed with milled profiles and one-side click nut or with PE80 overlay strip (50 mm x 10mm) without click nut. For thermal fixation (extrusion welding) on the fastening strip a gap of 10 mm is required.

Distance studs have to be removed accordingly.

The insert of a thin copper wire or aluminum tape as a counter electrode for the high voltage spark test has to be considered in the area of the joint. Furthermore, tackwelding of the sheet can be done with a PE-el welding rod (electro conductive).

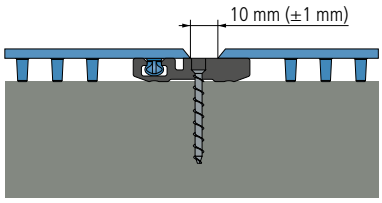


Figure 18: Groove width

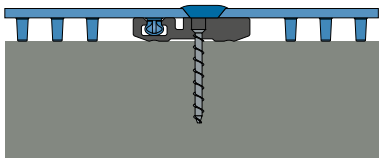


Figure 19: Extrusion welded

4.2.9 Pump sumps

Pump sumps have to be designed already during the engineering phase so that difficult welding of inaccessible corners is avoided. Also pipe penetrations of exhaust lines in pump sumps and the leakage pipe have to be considered before the installation of the sump.

Sump pit with leakage monitoring pipe, customized construction, preferably prefabricated.

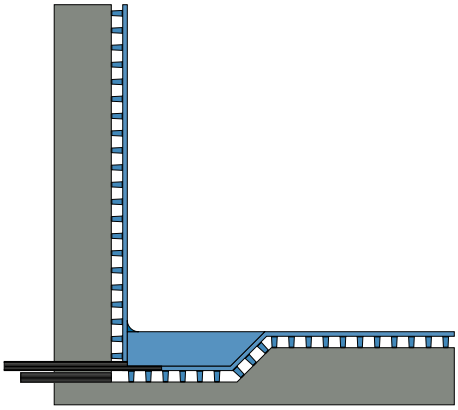


Figure 20: Sump pit with leakage monitoring and exhaust pipe (rectancular)

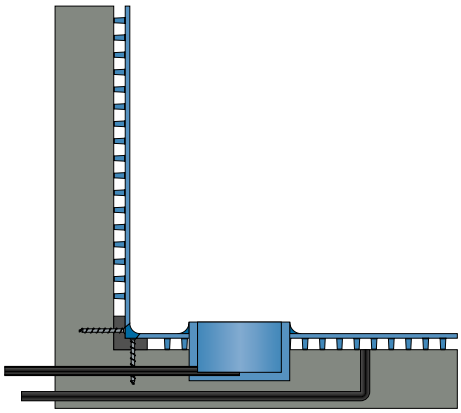


Figure 21: Sump pit with leakage monitoring and exhaust pipe (round)

4.2.10 Lining of pillars

Rectangular pillars should be performed by thermoforming. Extrusion welding is performed exclusively on the straight surface

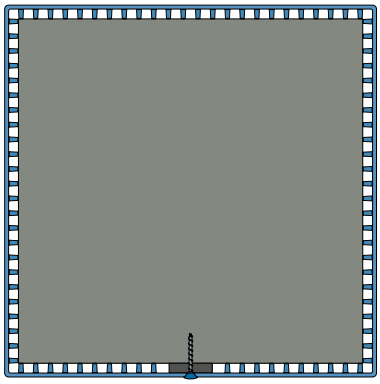


Figure 22: Rectangular Pillar

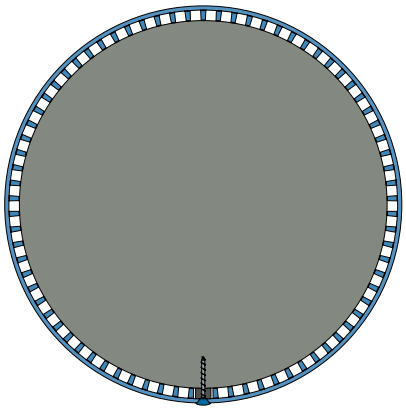


Figure 23: Round pillar

4.2.11 Pipe penetration

4.2.11.1 Puddle Flange

The pipe is cased and the annular space will be filled by mortar afterwards. As soon as the mortar is cured the installation of the HYDRO^{CLICK} system and the colar plate (PE 80, blue) can be started. Finally, everything is welded.

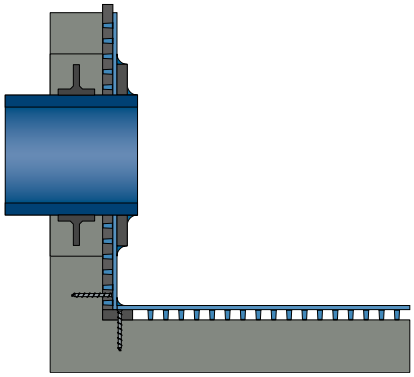


Figure 24: Pipe penetration with concrete connection socket

4.2.11.2 Concrete Connection socket

The implementation by concrete connection socket is mainly used for new constructions. They are mounted aligned to the formwork and cast into concrete.

After curing the installation of the HYDRO^{CLICK} system and the pipeline can be performed. Afterwards the colar plate (PE 80, blue) can be fixed and welded. Finally, the concrete connection socket is permanently and tightly connected with PE pipes by electrofusion welding.

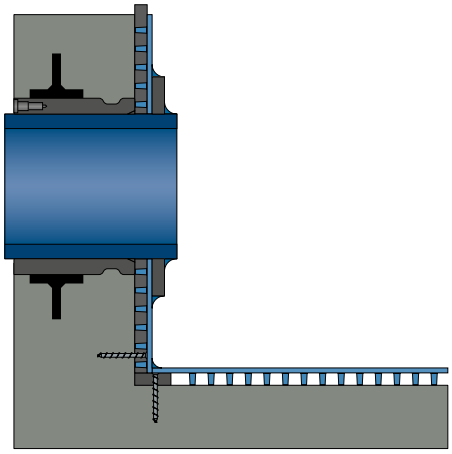


Figure 25: Pipe penetration with concrete connection socket

4.2.11.3 Link seal gasket

Hose pipe PE 80/PE 100 welded with inliner and sealing of gap by mechanical sealing kit.

NOTICE!
This kind of pipe penetration is not weldable (weldable compatible PE-Pipe penetrations shall be chosen)!

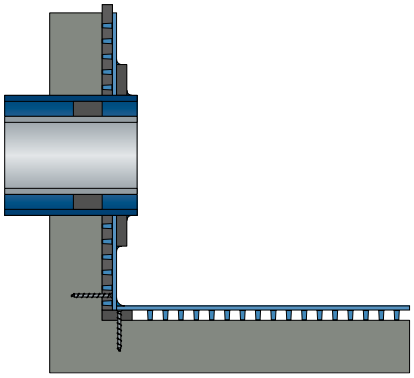


Figure 26: Pipe penetration with link seal gasket.

4.2.12 Wall termination

The wall termination is usually done with a milled PE 80 profile. Profile can be machined out of (PE 80, blue) sheets.

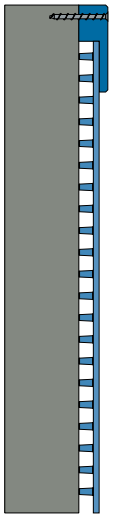


Figure 27: Wall termination with machined end profile.

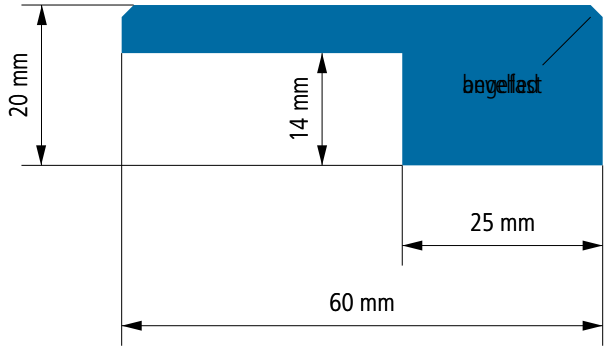


Figure 28: Dimension of milled end profile

TIP!
AGRU semi-finished sheets with the dimension 4m x 2m x 20mm are ideal.

It has to be considered that also HDPE endprofiles can be used for the wall termination.

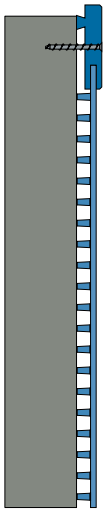


Figure 29: Wall termination with standard extruded end profile

It has to be considered that the wall termination at the roof area can be performed with (PE 80, blue) sheets.

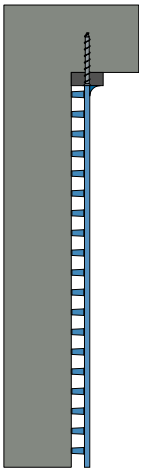


Figure 30: Wall termination at roof area

4.2.13 Mounting anchor fixations

Due to the required anchorage force or bearing pressure several possibilities of units or anchor elements can be executed.

4.2.13.1 Anchor system

... wall assemblies at tear-and shear forces

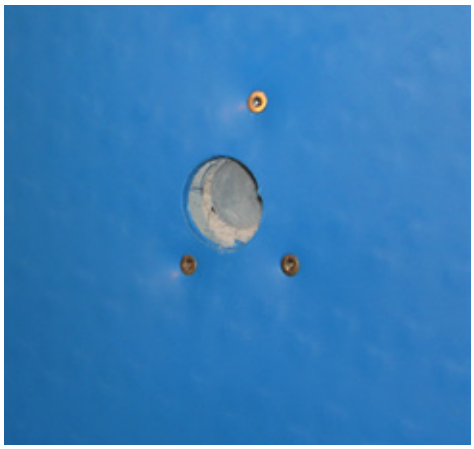


Figure 31: Prefabricated drill hole.

Figure 32: Assambling of the resin cartridge

Figure 33: Carefully assembling (screwing) into the plastic resin.

Fastening until the flange is sitting on the PE coating (remove extrusion resin before hardening).

Figure 34: BA-anchor during curing

After hardening and appropriate seam preparation the PE flange is extrusion welded leakproof to the wall lining.

Figure 35: Extrusion welding of the mounted BA-anchor

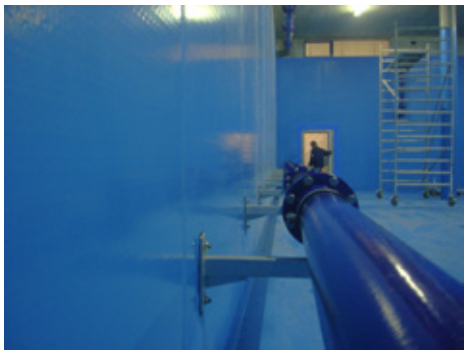


Figure 36: Mounted pipe line by the BA-anchor

4.2.13.2 Mounting plate

... only for pressure loads

Additional installation of anchoring of units with HDPE sheet built up and fixed on the subconcrete.

The unit fixing screws are fixed in backwards (with anti-twist safe-guard) and closed leakproof. (extrusion welding)

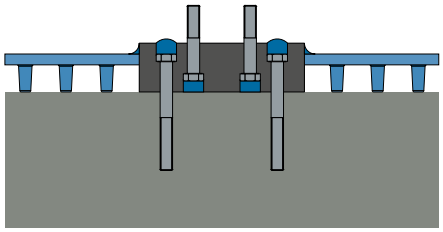


Figure 37: Screw fixation

Figure 38: Ladder fixation

Figure 39: Ladder feet

Figure 40: Ladder fixation

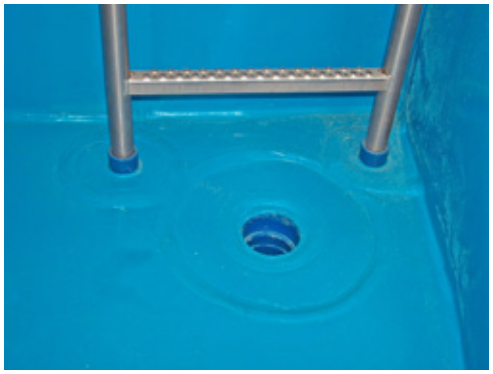


Figure 41: Ladder feet

4.2.13.3 Pipe support

Pipe supports are made of welded sheets for small surcharges.

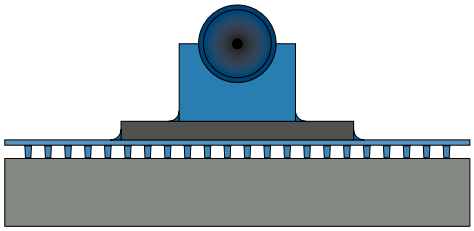


Figure 42: Pipe support

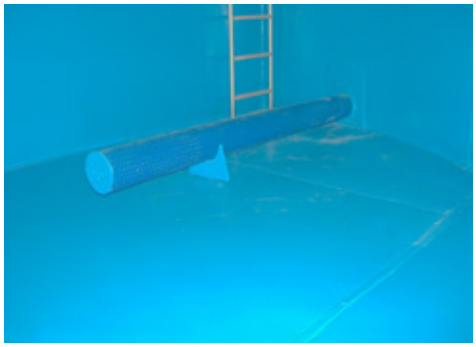


Figure 43: Pipe support with PE pipe

4.2.14 Pressure tight door

Flange construction with gasket and extruded PE 80 blue sheet (15 mm).

- Anchoring depth: > 50mm (depends on concrete quality)
- Centre distance: 100 mm - 300 mm
- End distance: 50 mm - 100 mm
- Stainless steel: 400 mm x 8 mm or 600 mm x 6 mm approved by the German Institute of Civil Engeneering

TIP!
The Etertub AG has a system solution for pressure tight doors.

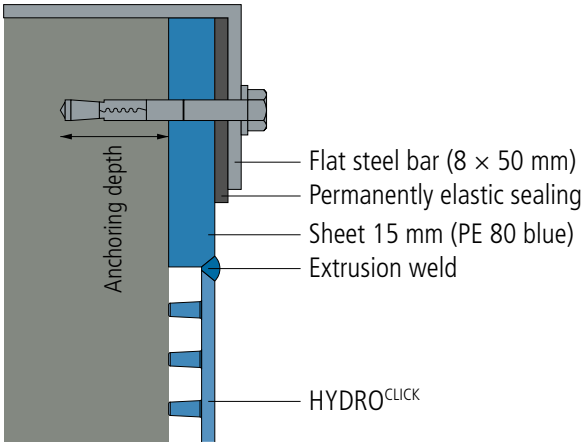


Figure 44: Pressure tight door construction - dimensions

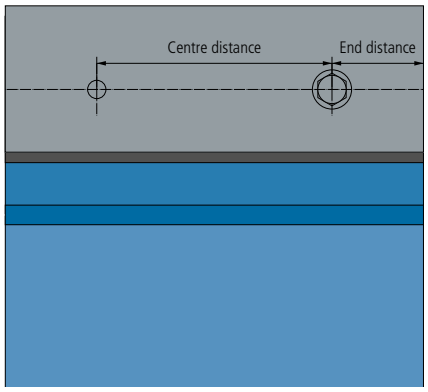


Figure 45: Pressure tight door dimension - distances

Figure 46: Assamblied pressure tight door

5 Welding technics

Welding on site has to be done after finished installation works according to the technical guidelines of the DVS.

IMPORTANT NOTE!
Sufficient ventilation in closed rooms must be ensured before begin of these works. Furthermore, air moisture should be as low as possible (e.g. heater fan) to avoid the influence of moisture to the welding joints.

5.1 Welding of HYDROCLICK

5.1.1 General guidelines

Welding works may be done only by experts who have provenly been trained in the perfect performance of the corresponding welding methods certification on thermoplastic welding according:

- DVS 2212 - 1 (UG I - 5) and
- DVS 2212 - 2 (UG II - 1) or
- EN 13067 material group 3 (minimum UG 3.1 and 3.2 hot gas welding, extrusion welding)
- and corresponding practical experience

The executing company has to be a certified contractor according to Art. 19i, para Part I-General Provisions relating to Waters.

It has to be ensure that only equipment is used which fulfils the requirements of DVS 2008 - 1, DVS 2208 - 2 and DVS 2209 - 2.

Welding protocols according to DVS 2227 - 1 have to be made which include an information about sheets, environmental conditions and welding parameters.

It has to be ensure that moisture or condensate do not affect the quality of the seam during welding.

Joining areas of the components to be welded have to be cleaned on the complete welding joint section. Welding areas have to be free of any contamination.

The oxidation layer in the welding zones of the sheets is preferably removed by scraping with suitable tool and the edge are bevelled 45° in the joint area.

5.1.2 Welding procedure

For the adjustment and check of the welding parameters, test welds have to be done with each equipment. All joints have to be done free of stresses as far as possible. Stresses resulting from temperature changes at installation and operation have to be kept as low as possible.

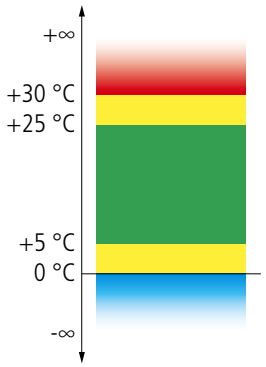


Figure 47: Installation temperature

IMPORTANT NOTE!
In general the ΔT of ± 10 °C corresponding to the installation temperature is authorized. if a higher ΔT is required, this issure have to be invariably checked with the technical department

With regards to the design and optic the joint geometry of HYDROCLICK linings is speciallly adjusted to the requirements for potable water applications.

The following welding methods are applied in dependence from the kind of connection:

- Extrusion welding (WE) DVS 2207 - 4 andDVS 2227 - 1
- Hot gas welding (WZ) DVS 2207 - 3
- Heated element butt fusion (HS) DVS 2207 - 1

Tackwelding and prewelds ca be done with hot gas welding.

Welds on site are only done with extrusion welding.

Prefabrications are performed by using hot gas welding, extrusion welding and heated element butt fusion welding.

For eventual improvements extrusion welding and hot gas welding have to be applied.

Environment conditons can influence the welding process and also the quality of the joint. The following has to be considered.

- Welding is not allowed at rain and too high air humidity
- Welding below +5°C can only be done under special precautions
- The surface temperatur must be minimum 3 K higher than the dow point (see table in appendix 1 DVS 2227 - 1) in case of 80 % air humidity
- The underground at hot gas extrusion welding has to be prepared accordingly to build up the needed joining pressure.

The joining areas and welding fillers have to be heated up to the necessary welding temperature (depending from the material). Only the surface areas of the parts to be welded should be heated up in order to keep the thermal expansion as low as possible.

Welding parameters and evironmental conditons have to be recorded in welding protocols. Welder, welding quipment and decives (typ and identification) and welding joint have to be listed in the protocols for traceability.

5.1.3 Connections to components and fittings

In order to have sufficient room for the welding works the mounting parts should be placed with a minimum distance of 0,5 m from the corners and fillets.

As sheets and components could be manufactured out of differen HDPE form masses with different melting points and melt-flow index values, the weldability has to be proved by testing the strength and deformation resp. failure behaviour.

It is recommended to use the form mass with the highest melt flow index as welding filler.

For having the same surface conditions for the welding process on both parts to be welded, it may be required to preheat the components differently by means of hot gas.

The components and fittings should be prefabricated under defined environmental conditions because of quality reasons. The corresponding DVS directives have to be considered.

5.1.4 Welding methods

For welding the HYDRO^{CLICK} sheets mainly the hot gas extrusion method is used. Depending of the thickness of the liner, the deposition extrusion welding, V- or fillet welding joints are applied. Hot gas string-bead welding can be used for the fixation of the sheets and in areas where extrusion welding is impossible.

Hot gas fusion is characterized by the following features:

- Welding filler (resin or rod) out of the same basic material
- The welding filler is plasticized in a plasticizing device (extruder) and put in the welding joint or joining area as a rope out from a die (welding shoe)
- The joining areas are heated up by hot gas (air) and plasticized
- The joining pressure is raised by means of the welding shoe
- The plasticizied welding filler is inserted to the welding zone with the welding shoe

A mass thrust appears which moves the device forward. The welding speed reults from the extrudate output of the welding extruder and the joint volumne.

To avoid a lateral mass waste the feed of the device may not be restrained. An eventual waste should be removed smoothly after cooling.

A further treatment of the welding joint is not necassary.

With depositon extrusion welds the front surface of the top semi-finished product has to be milled with an angel of 45°. To avoid a disperse of the overpalled areas, they are fastened by a fishtail die before joining with hot gas.

The plasticized welding filler is put on immediately after the joining zones reached the welding temperature.

In practice, welding by means of manual equipment is done today with the following parameter ranges:

- Hot gas temperatur 250 °C up to 300 °C
- Extrudate temperature 200 °C up to 230 °C
- Welding speed 0,2 m/min up to 0,6 m/min

PTFE is mainly used for the welding shoe.

The welding shoe is closed up front in welding direction. It is supported through the longitudinal edge on both sides by the sheets. Design and geometry of the pressure zone of the shoe influence the sizes of the joints.

For an expert and regular joint quality the welding shoe must have the following features in accordance to DVS 2207 - 4:

- pressure length minimum 35 mm
- width of the pressure zone (buckling) minimum 18 or 25 mm - see joints clicked, one-side clicked and non-clicked
- width of the lateral support areas with rounded edges an all sides of approx. 5mm
- a V-nose on the front of the welding shoe is recommended as centering and guide tool.

5.1.5 Tests on site

5.1.5.1 Kind and scope of tests

Tests and quality assurance measures have to be done on the welding joints during the construction phase. All tests on site have to be executed within the internal control by the installation expert. The results must be documented completely and reliable in test protocols.

Kind and scope of tests on site have to be done as following:

		Test scope	
Quality criteria	**Test method**	**In house control**	**External control**
Outside condition	visual	continuous	continuous
Measurements	manual	all test welds and spot checks	spot checks
Joint width joing thickness	manual	all test welds and spot checks	spot checks
Mechanical properties	tensile test	all test welds and spot checks	all test welds and spot checks
Tightness of joint	electric high voltage	continuous	continuous

Table 4: Tests

TIP!
Order for 3rd party inspection is the responsibility of the general contractor.

The above mentioned tests complete mutually with regard to the kind and scope. A statement about the quality of a joint only with one test method is impossible.

5.1.5.2 Control of outside conditions

The outside condition is tested by inspection. Mainly the manual performance of the joint is judged. Not welded zones can be recongnized by means of testing tool (bent-screw-driver). All joint areas are judged. Beginning from the joint edges, the joint is punctually inspected with a testing tool regarding joining defects. The testing tool penetrates into the joining defects.

The visual tests refers in detail to the following features:

- form and uniformity of the joint
- bead in the edge zones
- central position and regular edge zones
- notches and grooves in the joining area

The outide conditon of the joint is perfect when no irregularities and defects are determining. Small local irregularities, beads in the edge zones, notches and grooves with smooth transition and up to a depth of 0,2 mm do not reduce the function of the joint. Joining areas with larger and often appearing irregularities as well as defect joints have to be repaired.

In order to avoid uncertaincies during the installation phase it is recommended to fix the criteria for the outside conditions before the beginning of the installation with welding samples.

An expert judgement of the outside conditon requires special knowledge and experience. Statement regarding tightness and strength of the joint can be derived only conditionally.

5.1.5.3 Control of measurements

The following typical measurements of joints are determined:

- a ... thickness of seam at corner joints with depositin extrusion
- b ... withd of seam
- d ... sheet thickness
- f ... width of welding joint
- v ... sheet disalignment
- Δd ... welding bead oversize

The measurements have to be done with suitable measuring tools. Measurements on thickness are done with measuring tools acc. to DIN 53370.

It is controlled if the requirements are kept.

5.1.5.4 Control of the mechanical properties

The quality of mechanical properties (strenght, deformation and failure behaviour) are proved with short-term tests. These tests on site are mainly done on specimen taken from test welds within the internal control. They have to be completed with standard tests in the lab within the external control.

The tensile test in accordance with DVS 2203 - 2 can be done with all joint forms.

The welding joints are tested according to the actual performance. Minimum 3 (three) strips of specimen with a width of 15 mm are uesed.

The specimen is fixed so that the joint is centrally and square to the direction. The clamping length (clamp distance) should be 100 mm plus width of the seam. With the test of corner joints with deposition extrusion welding seams a clamping without stresses should be reached if possible.

With the evaluation of the test results it should be considered that also a bending load will appear beside of the tensile stress.

The test speed is 50 mm/min.

The test must be done until break resp. clearly beyond the yield point.

The result is used for the quality judgement of the deformation and failure behaviour of the welding joint. Furthermore the strength of the joint can be determined with corresponding equipment.

Basically the following kinds of failures could appear:

- clear stretching of the basic material beside of the seam (The seam fulfills the requirements)
- break in the transition area or in the welding filler (The seam fulfills the requirements conditionally, if this failure appears occasionally and the strength is within the scale of strength of unwelded areas.
- brittleness of the basic material outside of the seam (The seam does not fulfil the requirements)
- brittleness in the welding filler (The seam does not fulfil the requirements)
- rip up the seam (e.g. smooth break zone in the joining level) The seam does not fulfil the requirements

5.1.5.5 Test protocols

The results of tests on site must be documentated in test protocols (see appendix).

The protocols have to be written by the installer within the internal control, technically checked by the external control regarding completeness and finally countersigned.

5.1.5.6 Control of tightness (by electric high voltage)

In general, all joint forms can be tested with this method regarding tightness. The joint area must be dry and free of contaminations. The test is impossible with a closed film of moisture. Particles of dirt could build a lagging and could influence the test.

Before begin of the test, the sparking distance between the unit electode and the counter electrode (copper wire, metal foil, conductive PE, ...) in air and on a dry sheet surface with testing voltage has to be determined. The sparking distance is the distance of the maximum allowed untightness so that it can be recongnized. Higher air humidity and moist surface enlarge the sparking distance.

The sparking ball is carried through the joint with a speed of 2 up to 3 m/min. Untightness will cause a visible and audible sparkover.

The joint is tight when no sparkover appears. The limits of the method are that only untightness can be proven which is within the sparking distance.

The test method is based on the principle of gas discharge with the installation of electic high voltage to a discharge space. The test equipment consists of a high voltage source and an electrode.

In practice, sparking balls turned out to be more meaningful than brush electrodes.

5.1.5.7 Retreatments

Retreatments have to be done very properly because a test of these works according to all quality criteria and a further retreatment are only limited possible.

Joining works within retreatments have to be done acc. to DVS 2207.

The kind of retreatments depends from the size and frequency of irregularities and defects.

Additional deposition extrusion welds have to be done at locally limited irregularities and defects.

Corresponding joint areas have to be machined carefully. The welding filler should be applied with low thickness and flat ending edges.

At larger and continuous defects (holes), cuttings out of the corresponding sheets have to be applied.

5.1.5.8 Comments for system tests

The tightness of the sealing system can also be proven by system tests: Single layer systems are usually tested by flooding.

The tightness of drain pipes in the sump area can be proved by a 24-hours-test.

5.1.5.9 Comments for desinfection

The desinfection is done after the pressure test of the reservoir as tight construction.

Experts have to be consulted and the recommended effective time may not be crossed. Corresponding products free of chlorine have to be preferred.

5.2 Kind of joints-geometry

Constructive design: extrusion welding

For the construction of the components the guidelines DVS 2205ff are valid, for the design of the welding joints the guideline DVS 2205 - 3 and supplements to each directive are valid.

Particular attention is given to the following points:

- crossing joints have to be positioned as T-joints
- the distance between the joints should be minimum 50 mm
- the joint overlapping should be minimum 3,0 mm
- the joint reinforcement should be minimum 1,0 mm
- the total width of the joint depends from the design (see figure) welding joint overflows have to be machined by scrapers resp. have to be avoided by suitable welding shoes and guidance of devices.

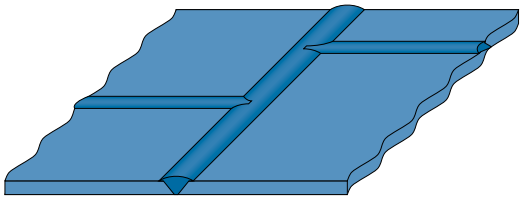


Figure 48: T-joints.

5.2.1 Standard joint for clicked sheets

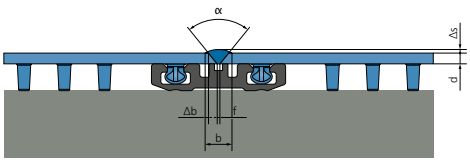


Figure 49: Clicked joint

Sign	Indication	Measurements
b	seam width	≤20 mm
d	sheet thickness	4.0 mm
f	gap width	max. 4 mm
α	V-angel	45° ≤ α ≤ 90°
Δb	edge welding zone	≥3 mm
Δs	seam reinforcement	1 mm ≤ Δs ≤ 2 mm

Table 5: Clicked joint - parameter

5.2.2 Standard joints for non clicked or one-side clicked sheets

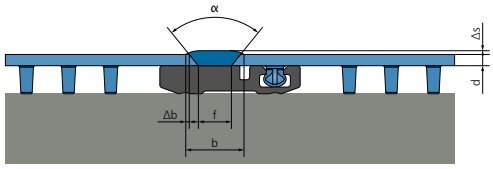


Figure 50: Non-clicked joint

Sign	Indication	Measuremnets
b	seam width	≤25 mm
d	sheet thickness	4.0 mm
f	gap width	max. 6-10 mm
α	gap width	45° ≤ α ≤ 90°
Δb	edge welding zone	≥3 mm
Δs	seam reinforcement	1 mm ≤ Δs ≤ 2 mm

Table 6: non-clicked joint - parameter

5.2.3 Deposition extrusion joint for welding gap width: f ≥ 10 mm

Fillet weld with tackwelding.

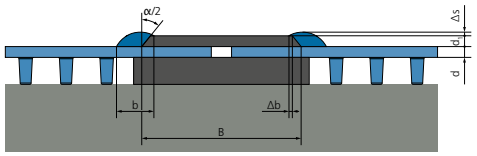


Figure 51: Welding gap ≥ 10 mm

Sign	Indication	Measurements
B	width of cover strip	60 mm ≤ B ≤100 mm
b	seam width	≤25 mm
d	sheet thickness	4.0 mm
d_1	thickness of cover strip	≥d
α/2	V-angel	30° ≤ α/2 ≤ 45°
Δb	edge welding zone	≥3 mm
Δs	seam reinforcement	2 mm ≤ Δs ≤ 4 mm

Table 7: Welding gap ≥ 10 mm - parameter

5.2.4 Floor-wall section

Fillet weld with tackwelding.

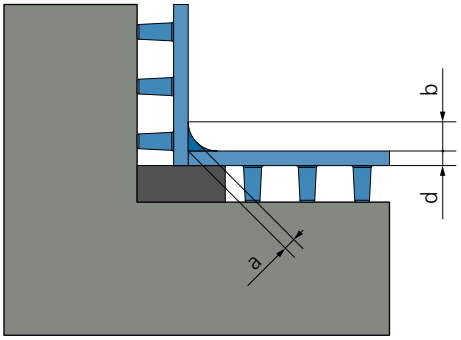


Figure 52: Floor wall section

Sign	Indication	Measurements
a	seam thickness	≥b/2
b	seam width	≥20 mm
d	sheet thickness	4.0 mm

Table 8: Floor wall section - parameter

TIP!
Before the extrusion joining in the floor wall section, a tackwelding with hot gas string bead welding has to be executed in order to avoid a movement of the sheets.

A counter electrode in the joining area is required for all joint sections to enable the high voltage spark test.

This counter electrode is included in the extruded click profiles as centrally coextruded thin electro-conductive layer out of HDPE-el.

Otherwiese the counter electrode has to be provided as electro-conductive alu-adhesive foil, copper wire or electro-conductive welding rod HDPE-el before the extrusion welding, as othewise the high voltage spark test will not operate accordingly.

Furthermore the test voltage has to be fit to the sparking distance (DVS 2227 - 1).

5.3 Welding protocol HYDRO^{CLICK} sheets

Welding protocol (in accordance of DVS 2227-4)								
Project				Sheet				
Installation company				Manufacturer				
Welder				Nominal thickness [mm]				
Welding protocol no.								
Seam-no.								
	Begin	End	Begin	End	Begin	End	Begin	End
Time	:	:	:	:	:	:	:	:
Weather conditions								
Air temperature [°C]								
Rel. air humidity [%]								
Liner condition								
General condition of surface								
Welding area								
Surface temperature [°C]								
Welding parameters								
Preheating temperature [°C] Setting Measurements								
Extrudate temperatur [°C] Setting Measurements								
Form of welding shoe								
Welding seam test								
Test weld (seam); no.								
Weld speciment; no.								
Notes								

Welder	Site manager (customer)	Supervisor (external)
Date	Date	Date
Signature	Signature	Signature

Table 9: Welding protocol (in accordance to DVS 2227-4)

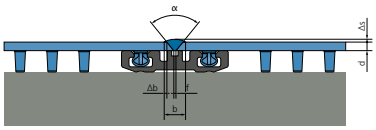
Test protocol (in accordance to DVS 2227-1 annex 3)	
Project	Sheet no.
Installation company	Seam no.
Welding method	Test protocol no.

External appearance of seam

Station	Run of seam	Bead design	Notches and grooves	Remarks

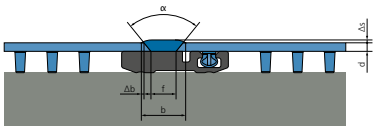
Measurements [mm]

Typ 1



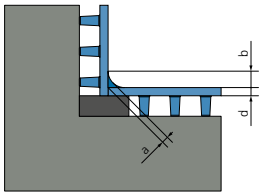
1 ≤ Δs ≤ 2
3 ≤ Δb
b ≤ 20
f ≤ 4

Typ 2



1 ≤ Δs ≤ 3
3 ≤ Δb
b ≤ 25
6 ≤ f ≤ 10

Typ 3



b ≥ 25
a ≥ b/2

Station	d	Δd	b	Δb	f	a	Remarks

Strenght (peeling test)

Station	Specimen width [mm]	Max. force[N]	Deformation and failure behaviour	Result	Remarks

Tightness - pressure test

Station	High voltage	Remarks
	Unit typ: Voltage [kV]:	
	Unit typ: Voltage [kV]:	
	Unit typ: Voltage [kV]:	

Welder	Site manager (customer)	Supervisor (external)
Date	Date	Date
Signature	Signature	Signature

Table 10: Test protocol (in accordance to DVS 2227-1 annex3)

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6 Approvals & Test Certificates

- W270
- KTW
- ÖVGW
- SVGW
- NSF-61
- Belgagua
- Nasthol
- KIWA
- ACS
- PZH
- SNAS

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