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# **TECHNICAL MANUAL -POLYETHYLENE PIPES**

## **FFP SPECIAL FM APPROVALS**

### **FOR PRESSURIZED FIRE FIGHT PROTECTION SYSTEMS**

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## WATER PIPES

### POLYETHYLENE PIPES FOR FIRE WATER DISTRIBUTION SYSTEMS

#### General

Polyethylene pipes for pressure fire water distribution systems are manufactured in accordance with the ČSN EN 12 201-2 standard from linear high-density polyethylene HDPE type PE100, PE100RC. The granulate manufacturers are members of the PE100+ association. The pipes are manufactured in black with blue stripes and are supplied in 6 or 12 m lengths, with dimensions up to 110 mm inclusive, as well as in 50 m and 100 m coils.

#### Polyethylene – PE (PE-HD)

In the early 1950s, low-pressure polymerization processes were developed that produce polyethylene with linear molecules. These processes are based on heterogeneous catalysts, for whose discovery Ziegler and Natta shared the Nobel Prize in 1963. The result of catalysed polymerisation at relatively low pressure and low temperature is high-density polyethylene, abbreviated to HDPE. Compared to the previous type, LDPE, this material has higher crystallinity and therefore significantly higher temperature resistance, strength, rigidity and hardness. PE-HD is a material composed of carbon and hydrogen. It has very good corrosion resistance and resistance to stray currents. It is also resistant to a wide range of chemicals, especially those commonly found in soil. Its high elasticity makes it highly resistant to the effects of soil settlement and other seismic anomalies..

#### PE100 Material properties

Density	0,955-0,965 g/cm <sup>3</sup>
Melt flow index	0,2-0,3 g/10 min.(190/5)
Coefficient of thermal expansion	$\alpha=0,2\text{mm/m.K}$ (for range 0-70°C)
Thermal conductivity	$\lambda=0,41\text{W/K.m}$
Surface resistance	$>10^{12} \Omega$
MRS	10 MPa

#### Usage

Polyethylene pipes for pressurized water distribution are designed for underground installation and are approved according to the pipe laying certificate. The pipes must not be installed for indoor distribution; pipes not laid underground must be secured using protective sleeves and protected from heat sources with insulation.

#### Service life

The service life of PE pipes is according to the applicable standard ČSN EN 13501-1, classification code 730860. Based on the strength isotherm, a service life of up to 100 years/20° C can be considered, depending on the conditions.

## Fire rating of piping

Polyethylene is a Class C3 combustible material according to ČSN 730860, i.e. it is classified as flammable.

## Environmental and economic aspects of use

Polyethylene is supplied as a polymer that is harmless to health. No substances harmful to health are used in the manufacture of PE pipes. The use and storage of PE pipes is environmentally friendly; when PE burns, it produces emissions similar to those produced when burning a paraffin candle. The most environmentally and economically advantageous disposal of used PE pipes and waste generated during their installation is problem-free recycling.

All materials used for packaging LUNA PLAST, a.s. products are classified in category O, i.e. other waste.

## Approval, certification and marking of pipes

Plastic pipes supplied by LUNA PLAST, a.s. are certified by an authorized body in accordance with the provisions of Section 10 of Act No. 22/1997 Coll. on technical requirements and in accordance with the current government regulation, which sets technical requirements for construction products, and also by the FM Approvals certification authority.

LUNA PLAST, a.s. has implemented a certified quality management system in accordance with ČSN EN ISO 9001 (2015) issued by the certification body TÜV Süd.

## PE pipes are marked every meter with the following data

Manufacturer – Product designation – FM Approvals mark and name – Material – Dimensions – SDR – Standard – Date of manufacture – Batch number – Production line number – Length in meters

## TRANSPORT, STORAGE AND HANDLING OF PIPES

Transport, storage, and handling of PE pipes complies with the ČSN EN 12 201-2 and AWA C906 standards.

During transport and storage, pipes must lie flat on the ground along their entire length to prevent bending and protect them from being bent at the edges. Bar material exceeding the loading area of the vehicle by more than 1 m must therefore be supported during transport. The loading area of vehicles must be free of sharp protrusions (screws, nails), and the surface of the storage area must not be stony.

When storing pallets in multiple layers, it is necessary to ensure that the reinforcing beams of the pallets lie on top of each other and that there is no point loading on the pipes in the lower pallets (see Fig. 1). The support beams should not be narrower than 50 mm, and the maximum height of stacked pallets is 3 m. The maximum storage height of pipes unpacked from pallets is 1 m. Side supports should not be more than 3 m apart.

Pipe coils are stored either upright on suitable supports (e.g., rubber strips – the ends of the pipes must point downwards to prevent water ingress) or horizontally up to a height of 1.6 m.

Pipes and fittings can be stored outdoors. It is advisable to prevent direct exposure to sunlight. The total storage time of products stored in this way (black colour) should not exceed 2 years. Pipes should be issued from the warehouse in the order in which they arrived at the warehouse.

The products must be protected from contact with solvents and from contamination (moisture) of the inner surface. Do not store them near heat sources; plastic pipes are not affected by frost.

It is not permitted to throw pipes during loading and unloading. It is also not permitted to drag pipes over sharp gravel and other sharp objects (use rollers or pads). Pipes or parts of pipes or fittings that show damage deeper than 10% of the wall thickness must be considered unsuitable for use at the nominal pressure.

### **Unrolling the scrolls**

Unroll the coils at temperatures above freezing (pipes stored at lower temperatures must be tempered for at least two hours; sometimes it helps to leave the coil in the sun). Heating the coils with steam or hot air is prohibited.

To unroll the coils, we recommend using an unwinding device (trolley) that allows you to hold the outer layer of the coil after removing the binding tape (see Fig. 2) and that has a straightening device (see Fig. 3). First, remove the tape securing the outer end of the pipe, and then gradually release the other layers. We recommend releasing only as much pipe as is currently needed. After separating part of the pipe, replace the cap on the remaining part of the pipe and check that the coil has not been damaged. Care must be taken not to scratch the pipe when removing the binding tape, and if an unwinding device is used to unroll the coil, care must be taken not to scratch the pipe when moving it on the ground or other objects. The pipe is cut to the required length in the usual manner. The bending radius depends on the ambient temperature.

Coils with larger diameters (75 mm and above) and higher SDR (SDR 17 and above) exhibit higher ovality. This phenomenon reflects the laws of physics and cannot be eliminated during production (or during the production of transportable coil sizes). Higher ovality during butt welding can cause the permissible pipe misalignment tolerance to be exceeded in the least favorable combination of local pipe diameters, and therefore certain measures must be taken. Thanks to the shape memory of the material, ovality can be partially eliminated by simply unfolding the pipe at normal temperature approximately 24 hours before welding. In addition, however, it is necessary to use a rounding device during welding and to observe the time required for the material to cool. Due to the high deformation forces in the pipe wall, coils of these higher SDRs also show a very strong tendency to "break" the pipes, especially in the inner layers (the buckling strength of thin-walled pipes is lower). However, this does not rule out the possibility of breakage during transport, further storage, and handling on site. For the above reasons, we ask customers to take the described phenomena into account when using the product and to adjust their orders according to the current situation. If a pipe "breaks," the affected section must be cut out.

### **Piping routing**

Appropriate fittings are used to change direction. Hot forming of pipes on site is not permitted. However, the flexibility of PE allows changes in direction or copying of the terrain by creating bends with a radius R, for which the following applies depending on the temperature:

Temperature	20°C	10°C	0°C
Arc radius R	20xD	35xD	50xD

D - outer diameter of pipe

## PIPE CONNECTION

Water pipes can be joined by butt welding or by connecting them using electrofusion fittings. The essence of welding is that the joints of pipes or fittings are brought to a state by the supply of thermal energy that allows the molecular chains of the welded parts to interconnect, with the necessary connecting pressure being applied for the connection.

Materials with a melt flow index (MFI 190/5, according to ISO 1133 or ČSN 64 0861) between 0.2 and 1.4 g/10 min can be welded, or materials for which the manufacturer guarantees weldability with these materials. There are no restrictions on welding PE 80 and PE 100 pipes together.

Welding is prohibited at temperatures below freezing. Individual welding conditions are governed by the instructions of the manufacturer of the electrofusion fitting or welding machine.

### Welding with electrofusion fittings

An electrofusion fitting is essentially a sliding socket equipped with a heating coil as a source of heat necessary for welding. It is designed so that after the required amount of energy is supplied, the necessary temperature of the pipes and fittings is achieved and the necessary connection pressure is created. For welding, it is necessary to use welders whose parameters correspond to the fittings used, follow the manufacturer's instructions, and comply with the fitting manufacturer's instructions. The lowest ambient temperature at which welding is permitted is determined by the properties of the electrofusion fittings (as recommended by their manufacturer) and does not depend on the properties of the pipe.

### Preparation for welding

In the welding area, the ovality of the pipe must not exceed 1.5%; otherwise, a rounding device must be used. Pipes intended for connection must be cut perpendicular to the longitudinal axis and deburred. Electrofusion fittings can also be used to connect pipes with different wall thicknesses.

Absolute cleanliness of the pipe and fitting is a prerequisite for good welding. Before welding, the surface of the pipe ends must be cleaned of the oxidized polymer layer using a scraper or scraper, over a length greater than the insertion length of the fittings, and then degreased with a suitable cleaning solution. In case of contamination, or if prescribed, the inner surface of the fitting must also be cleaned. The fitting must fit onto the pipe without any play, and its connecting clamps must be clean and undamaged. The insertion depth must be marked or checked using a suitable device. If there is a risk of mutual movement of the welding parts, measures must be taken to prevent this (clamps, other devices).

### Welding

After placing the electrofusion fitting on the ends of the pipes, connect it to the welding machine so that the cables or clamps are not subjected to excessive stress. The welding machine reads the welding data

automatically (by scanning the barcode); otherwise, it must be set manually. When using the welding machine, follow the operating instructions.

Welding after start-up proceeds automatically until the end of the process; the device usually indicates the welding time. If it is not automatically stored in the device's memory, it is recorded in the welding log. The joint may only be subjected to mechanical stress after the weld has cooled thoroughly in accordance with the regulations for the specific fitting.

A visual inspection of the correct execution focuses on determining whether the weld is clean and even, and whether the shape of the weld (overflow) and the control indicators of the fitting are in the correct position (verification of welding pressure).

### **Butt welding – general requirements**

Only pipes with the same wall thickness can be welded. Before welding, it is necessary to check the ovality of the pipes (especially for pipes supplied in coils). It is advisable to unroll the coils the day before so that some of the deformation relaxes, or to bend the pipe (as close to the weld as possible) using a clamp or an inserted "calibration block".

Only welding equipment with a valid certificate of verified functionality may be used for welding. Clamping devices must always be used; they must not damage the surface of the pipe, and the pipe must not stick. The manufacturer's instructions for the welding machine must be followed during operation.

Welding may only be performed by persons with a valid welding certificate. Records of individual welds must be kept in the following scope:

- weld number and date of execution
- identification of welded parts (type, dimensions, manufacturer, pressure range)
- identification of welder
- identification of welding equipment
- welding conditions

### **Preparation for welding**

Welded parts must be coaxial during welding and cooling, with a maximum offset equal to one tenth of the pipe wall thickness  $x_1$  (Fig. 4). The ends of the pipes must be free of oxidized polymer layers. The pipe ends must be cut so that the maximum width of any gap  $x_2$  (Fig. 4) between the ends of the pipes resting against each other is within 0.5 mm, and within 1 mm for pipes over 400 mm.

Planing is done correctly if a continuous strip (shavings) is achieved at both ends of the pipes. Weld immediately after machining the surfaces. The ends of the pipes must be clean, free of grease, burrs, and chips. Do not touch the welded surface. Use factory cleaning fluids (e.g., Tangit) or isopropyl alcohol for cleaning.

The absorbent cleaning cloth (scarf) must not shed fibers or dye, and must not be used repeatedly. The temperature of the welding mirror must be stabilized for at least 10 minutes, evenly distributed between 200° C and 220° C depending on the wall thickness (see Fig. 5). The temperature must be checked more frequently at lower temperatures and with stronger air movement (measured in the area of the mirror that touches the pipe wall during heating).

Before welding, the force required to overcome the passive resistance to pipe displacement ( $F_0$ ) is determined and the total force applied is calculated. This is the sum of  $F_0$  and the contact force  $F_p$ .

$$F = F_0 + F_p$$

The force required to align and join the pipe ends is given by the specified pressure of 0.15 MPa (N/mm<sup>2</sup>). The required data must be used according to the units used on the welding equipment.

## Welding

The welding diagram graphically illustrates the welding process – see Fig. 6.

The welding process has several phases:

- Alignment time: alignment of edges and formation of a weld bead (weld collar)
- heating time: time for heating the material at minimum pressure
- welding mirror replacement time: time required to remove the welding mirror
- joining pressure time
- cooling time at the specified pressure

After heating to the specified temperature, the ends of the pipes are pressed onto the welding mirror with the calculated force (pressure) until they fit together around the entire circumference. A uniform bead with a height of "k" is formed at the joint, as shown in Fig. 7.

After the necessary equalization time  $t_1$  has elapsed, the pressure is reduced to 0.02 N/mm<sup>2</sup> and the joint is heated for the time specified in the table (heating time  $t_2$ ).

The time for replacing the  $t_3$  has a significant impact on the quality of the connection. The mirror is quickly removed from the weld so that the surface of the pipe is not damaged or contaminated.

The welded ends are quickly moved together, but the actual connection of the two welded ends must be done at the lowest possible (almost zero) uniform speed (the time is calculated from the moment the mirror is moved away from the welded surfaces to the moment of their first contact). Do not extend the replacement time under any circumstances!

After connecting the pipe ends, the required welding force of 0.14–0.16 N/mm<sup>2</sup> develops during the connection pressure time  $t_4$ , and the weld is left to cool while maintaining this force ( $t_5$ , protected from direct sunlight). Keep the temperature rise to a minimum if possible. The pipe can only be released from the clamping device after the  $t_5$  period has elapsed, which must not be shortened by cooling the pipe.

Pipes up to 160 mm can be mechanically loaded at normal temperatures only after at least 1 hour (for pipes over 315 mm depending on wall thickness) from the end of the welding interval, i.e. from the end of the cooling period of the last weld (pressure test).

	T1	T2	Replacement time	T3	T4
pressure (N/mm <sup>2</sup> )	0,15	min.0,02			0,15 (0,14-0,16)
Wall thickness <b>b</b> (mm)	height <b>k</b> (mm)	T2=10xb (s)	max. time (s)	(s)	(min)
4	0,5	40	5	4	6
5	1	50	5	5	7
6	1	60	5	5,5	8,5
8	1,5	80	6	6,5	11
10	1,5	100	6	7	12,5
12	2	120	7	8	16
15	2	150	8	8,5	19,5
20	2	200	9	10,5	25
25	2,5	250	10	11,5	31
30	2,5	300	10	13,5	36,5
35	3	350	11	15,5	42,5
40	3	400	12	17	48,5

### Visual weld inspection

To assess whether a weld has been performed correctly, an even bead should be created around the entire circumference of the weld. When welding different types of material (PE 100 and PE 80), its height and shape may not be the same on both welded parts. A series of identical welds should have the same appearance. The bead must be extruded onto the surface of the pipe at all points of the weld. The color of the welded material must not differ from the color of the original material. The weld bead must not contain pores (bubbles), inhomogeneities of any kind (impurities), or cracks, and the weld must not show any pipe displacement greater than one-tenth of the wall thickness. Sharp notches in the weld bead recess are not permitted. The surface of the pipe around the weld must not be excessively damaged (by clamping devices, etc.).

### PIPE COMPRESSION

Compressing pipes to stop the flow of media is currently often used when using polyethylene pipe systems (Fig. 10). This is particularly necessary in cases of expanding networks using new connections, when resolving faults, etc.

Compression can be performed if the distance of the compression device is at least five times the outer diameter of the pipe from the point of damage, weld, or previous compression (e.g., for a dimension of d

90, this is 450 mm). After removing the compression device, the pipe is bent and left in the bending jig for at least 1 hour.

After completion, we recommend visibly marking the compression point in a permanent manner to prevent multiple compressions at the same point, and marking it in the operational and technical documentation.

## METHOD OF INSTALLATION

### Production range:

POLYETHYLENE PIPES FOR PRESSURE WATER DISTRIBUTION type PE100

- Installation in open trenches

### INSTALLATION IN AN OPEN TRENCH

The route design and installation must comply with the requirements applicable in the relevant field of use, in particular according to: ČSN 733055 (issued in August 2018), ČSN EN 805 (issued in July 2012), ČSN 755401 (issued in December 2007).

#### Backing

The pipeline is laid in a trench on a compacted sand or gravel-sand bed (backfill). Only mined sand or other non-sharp-edged material with a maximum size of 16 mm may be used for gas pipelines.

Fig. 8 - The bottom zone must be created according to the slope of the pipeline. The pipeline must not be laid on frozen soil, whether natural or filled. The angle of installation  $\alpha$  must be greater than  $90^\circ$ .

The pipeline must lie on the ground along its entire length (angle of installation greater than  $90^\circ$ ; it is particularly important to prevent the formation of point contacts, for example on rock protrusions or necks). In rocky subsoil, it is advisable to create a new bed after removing a layer of approx. 10 cm.

Direct laying on concrete (concrete slab) is also prohibited; if the situation requires such laying, the concrete must be provided with a compacted bedding.

#### Backfill pipes in the active layer

An active layer is defined as a layer of soil at least 20 cm above the upper edge of the pipe, with a minimum width of 0.15 m from the outer surface of the pipe. The soil is poured from a reasonable height to avoid damaging the pipe.

Backfilling and compaction are carried out in layers, always on both sides of the pipe (especially in the lower half of the pipe and at the connection points of unsupported T-pieces). Compaction is performed manually or with light mechanical tampers; the top of the pipe is not compacted. During compaction, care must be taken to ensure that the pipe does not shift in height or sideways.

No cavities must form around the pipe. Therefore, materials that may change in volume or consistency over time cannot be used for backfilling – soil containing pieces of wood, stones, ice, wet cohesive soil, organic or soluble materials, soil mixed with snow or pieces of frozen soil.

It is advisable to protect the material used for backfilling the trench from moisture.

When laying pipes in terrain with groundwater, it is necessary to prevent soil washout. The trench must be free of water during installation (to prevent the pipes from being washed out). If drainage is used, it must be removed after completion of the work. Avoid unnecessary stress on the pipes on site, such as driving over insufficiently backfilled pipes with vehicles.

### **Main pipeline backfill**

Material that can be compacted without difficulty shall be used for backfilling. Suitable mechanisms shall be used to achieve the required compaction; for more detailed information on compaction, see EN 1046:2000. From a cover depth of 20 cm, compaction is also possible above the pipe. Where excavated material is to be reused, the surface layer must be stored separately from the rest so that it can be returned to its original location. This is particularly important when excavating agricultural land. Earthworks must be recorded in the construction log (depth and width of excavation, method of compaction, layer heights, etc.).

## **READINESS FOR USE**

Before commissioning, the integrity of the installed piping must be verified in accordance with applicable standards. This verification usually includes a pressure test of the piping, submission of construction documentation and drawings of the finished state, and confirmation of preliminary acceptance.

## **PRODUCT RANGE – BASIC INFORMATION**

Technical Data Sheet FFP-SPECIAL FM Approvals

**FIGURE APPENDIX**

Figure 1

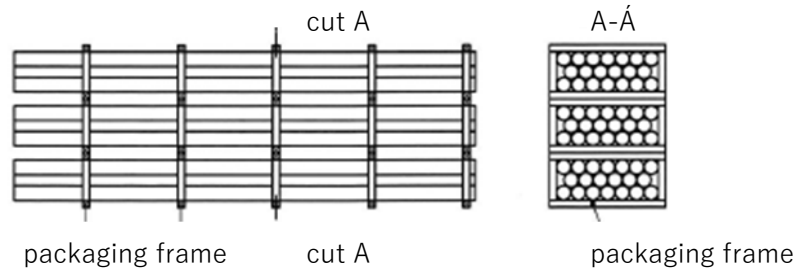


Figure 2

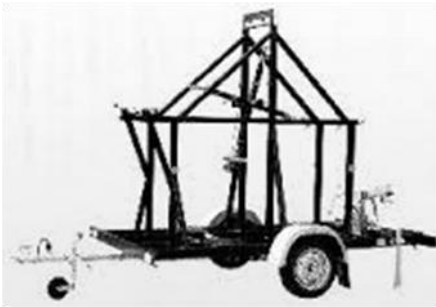


Figure 3

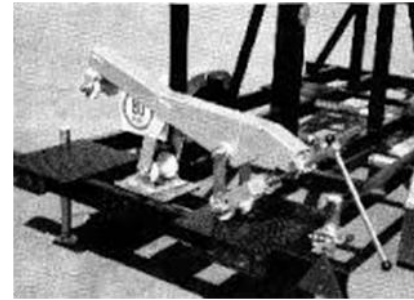


Figure 4

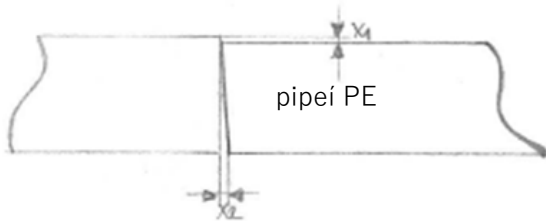


Figure 5

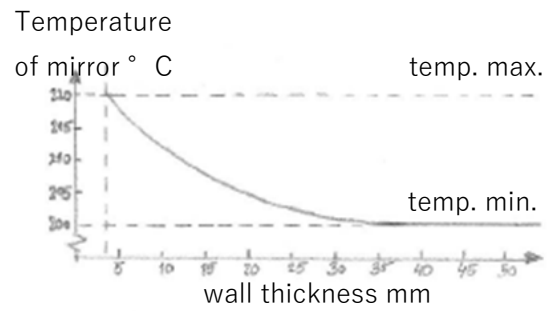
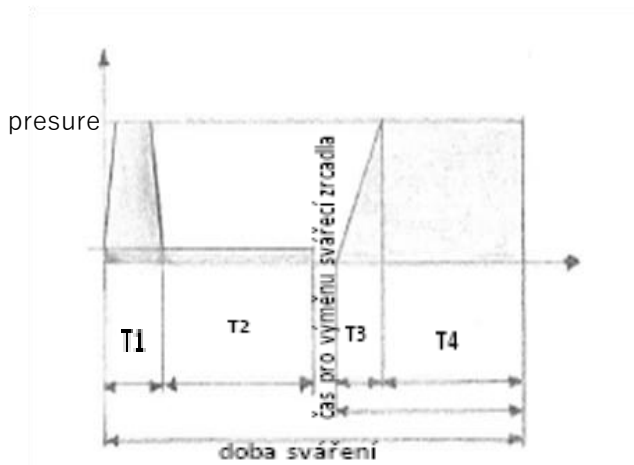
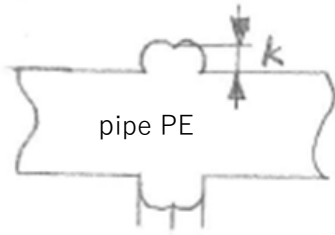


Figure 6

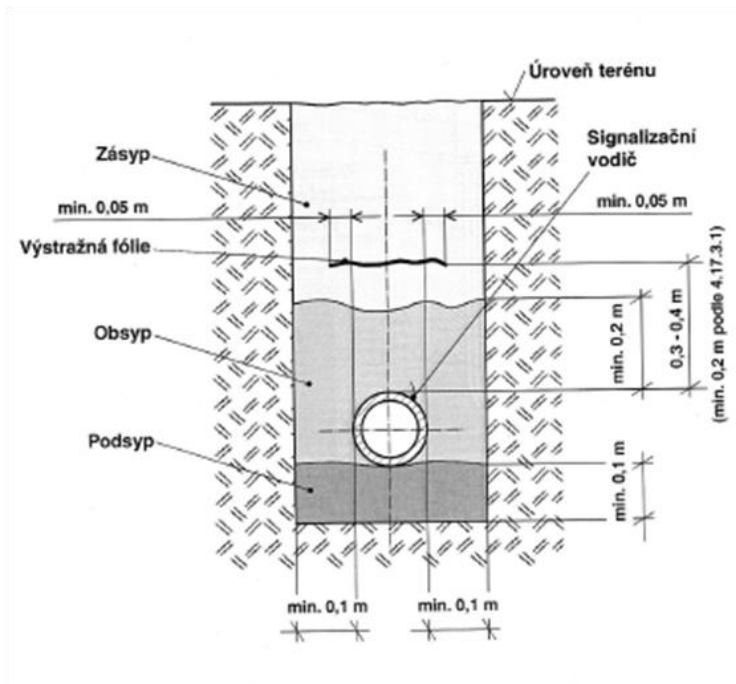


- T1 – Alignment time
- T2 – Heating time
- T3 – Joining pressure time
- T4 – Cooling time

Figure 7



Example of pipe installation in an open trench  
Figure 8



Principle of use of compression devices  
Figure 10

