MANUAL
FOR PLUMBER

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1. Introduction

1.1. Information about the IPCIC project

The main objective of the project was to improve education in the field of construction, in line with new legal regulations and construction sector trends. To achieve that goal, training system was prepared. It contains knowledge necessary for the finishing works specialists and tutors (mentors), with particular emphasis on efficiency of work and quality of education, H&S regulations, and soft skills. The main subjects are: drywall fitter, plumber and tiler. Project also helps to improve mobility of construction personnel, due to its international content (presentation of practices from participating countries) and multi-language form (materials prepared in EN, PL, LT and IT and help users to learn vocabulary specific for finishing works). The project complies with EQAVET requirements and it is foreseen that it should increase quality of didactic process for construction workers education including CPD. The objectives of the project include promotion and improvement of cooperation between construction industry and VET providers, including WBL scheme (that is why one of the partners in the project is a construction company). The partnership was established to ensure the best quality of results. It consists of VET organizations from Italy, Lithuania, and Poland (Centro Edile A. Palladio; Viesoji Istaiga Vilniaus Statybininku Rengimo Centras; Centrum Kształcenia Zawodowego i Ustawicznego Nr 1 in Warsaw), construction company (ERBUDS.A.), professional association (Polish Association of Building Managers - the Project Promoter) and university (Civil Engineering Faculty of Warsaw University of Technology). Target groups of the project are: young people, participants of CPD courses, young technicians, construction workers (also those who would like to retrain), stakeholders and associations in the construction sector, SMEs and companies (construction sector); providers of future courses: vocational schools, technical schools (primary and secondary - depending on the national systems terminology); VET providers, teachers, mentors; construction companies (training departments). 5 intellectual outputs were prepared: courses programmes, courses methodology, didactic materials, movie materials, materials for teachers training. All the results were presented and tested during multiplier events.

1.2. General information about the profession

A specialist fitter of water/sewer systems and heating systems deals with a wide range of these internal systems, installation all system elements and equipment as well as any accompanying works (e.g. insulation). The fitter of water supply/sewer systems and heating systems uses both traditional elements (PVC ceramic/cast iron sewer pipes), transport pipes with threaded/welded/soldered connections, as well as modern systems of mixed-material pipes joined by twisting/ welding/ gluing/system clamps etc., as well as any available insulation technologies related to these systems.

In Poland the plumber professional qualification is obtained at educational institution specialized in vocational training (i.e. plumbing installations related activities), usually at the end of a secondary school cycle. In terms of dealing with networks of heat supplies above 50 kW of power, special state exam and certificate is required by the law, according to the Regulation of the Minister for Economy,

Labour and Social Policy from 28th of April, 2003 (on the detailed rules for determining the qualifications of persons dealing with operation of equipment, installations and networks).

In Italy plumber VET training is regulated in accordance with Regionals' Occupational Standards.

As a general national principle, the professional qualification is obtained at a state or legally recognized institution specialized in plumbing installations activities, at the end of a secondary school cycle, as provided in Article 1 of Ministerial Decree 37/2008, followed by a period of internship in a sector-related company for at least two years.

In Lithuania plumber training is regulated in accordance with the national Occupational Standard for Construction Sector (Statybos sektoriaus profesinis standartas). Plumber qualification (national registration code: M43073201, M44073201, T43073206) can be acquired following the path of initial or continuous vocational education and training.

According to ESCO (European Skills, Competences, Qualifications and Occupations), the plumber occupation is included under the category „Building and related trades workers" ((ISCO-08 code 7126). Plumbers maintain and install water, gas and sewage systems. They inspect pipes and fixtures on a regular basis or make repairs as needed. They bend, cut, and install pipes. They test systems and make adjustments safely and following regulations. (https://ec.europa.eu/esco/portal/occupation)

1.3. Learning Outcomes

SPECIFIC TASKS AND ACTIVITIES OF THE PROFESSIONAL FIGURE

We offer a division of training on the level of specialization:

BASIC TRAINING: is intended to educate the fitter's helper (apprentice) who will perform simple auxiliary works as basic activities:

- Preparation of a safe workplace,
- Preparation of materials for installation of internal water and sewer systems and heating systems,
- Routing, preparation and installation of hangers, clamps, supports,
- Installation of simple water and sewer systems using basic tools,

ADVANCED TRAINING: is intended to educate an independent fitter (master) who with the help of specialized tools will be able to implement selected sanitary installations:

- The trainee installs complex water, sewer and central heating systems in multi-family, public and industrial buildings,
- The trainee builds complex internal systems including installation and connection of equipment, using specialist tools such as threader, crimper, heat sealer etc.

COMMON SKILLS

They are identified as common skills at the two levels:

A. Planning and organization of their work.

B. Installation of water, sewage and heating installations.

SKILLS FOR THE BASIC LEVEL

The installation of simple water, sewage and heating installations as a specific process for the basic level.

SKILLS FOR ADVANCED LEVEL

The installation of complex water, sewage and heating installations systems is identified as a specific process for the advanced level.

KNOWLEDGE, ABILITY AND SKILLS ASSOCIATED WITH PROFESSIONAL ACTIVITY

The basic course corresponds to the sum of the knowledge, skills and competences of levels 1, 2 and 3, while the advanced course corresponds to the sum of the knowledge, skills and competences of level 4 in Table 1.1.

Table 1.1: Knowledge, skills and competences

Level	Knowledge	Skills	Competences
1	Basic general knowledge of: - language, aimed at reading and understanding documentation, systems, materials and products which will used; - materials and tools. - preparation of a safe workplace	Identify the materials, products and tools according to the deliveries received.	Assist in laying and learn basic information on the use of materials, products and tools used.

2	Preparation of tools, equipment and machinery. Knowledge of basic and recurring operations,	Understand the function of the individual tools and the individual equipment and their methods of use. Operate alongside top-level operators, solving recurring problems and employing simple tools and rules.	Prepare tools, equipment and machinery necessary for the various works, based on the instructions received and the expected final result. Cooperate in the field of performing basic and repetitive installation activities
3	Knowledge of systems for internal water / heating installation types and correct application - depending on the needs	Evaluate the laying site and identifying solutions, tools and materials regarding the proper type of installation.	Check the installation context and the surrounding conditions. Check that the products / materials / systems are equipped with the prescribed technical documentation Independent layout and selection of spacing of appropriate slings. Self-installing anchors Drilling and installation of tubular slings. Installation of simple water and sewage installations. Installation of simple heating installations. Adopt behaviours and solutions aimed at correcting any anomalies in relation to the finished work. Clear and clean the workplace. To deliver the work and release the required documentation.

4	Knowledge of the different types of internal installations, of complementary materials / products, their characteristics and their application methods according to their use and their intended use. Knowledge of: - safety, hygiene and environmental standards; - processes and work cycles related to different types of internal installations; - correctly reads the delivered designs and operation and maintenance manuals of the equipment - plans works and supplies and selection of materials and equipment necessary to perform them - correct and safe use and maintenance of machines / devices / tools Using the correct types of assembly and making installation connections; Solving simple problems related to insufficient documentation and removing collisions.	To evaluate the installation context and the related surrounding conditions, identifying specific solutions, tools and materials for the correct type of installation. To identify: - technical and design documentation - materials, products, and tools; - criteria for organizing their work in relation to the activities to be performed and the context; - methods of planning and organization of work in relation to the advancement of work on the construction site and occupational health and safety To evaluate: - procedures and techniques for the preparation of products, tools and equipment in relation installations performed. In the presence of activities with y installation teams - assignment of tasks and roles to individual persons, selection of appropriate materials and tools, taking into account expected final results.	To manage independently the own activity in the context of job, from the management of the economic offer to the delivery of the finished work, also with reference to: - checking of the installation context and related conditions of the context; - checking if relevant products / materials / systems are accompanied by appropriate documentation; - independent installation of internal water and sewerage and heating systems; - independent execution of internal installations with assembly and connection of specialized tools; - checking the correctness of the work performed in relation to the design or specification; - clearing and cleaning the workplace; - delivery of the work and release of the prescribed accompanying documentation. To adopt procedures, techniques, behaviours and solutions aimed at overcoming and eventually correcting anomalies and / or observations in relation to the finished work. Coordinating and overseeing the work of others, assuming the relative responsibility for the assessment of the installation activities.

2. Legal aspects of the profession

2.1. Safety of works

Occupational Health and Safety (OHS) - a set of terms and rules regarding safe and hygienic performance of work and creating proper work conditions prescribed by the law and built based on experience.

The basic legal act guaranteeing all persons the right to safe and hygienic conditions of performed work is the Constitution of the Republic of Poland. The guidance for exercise of the said legal guarantees is the act referred to as the Labour Code, along with secondary legislation (including the secondary legislation to Art. 273^{15} – including but not limited to the Regulation of the Minister of Labour and Social Policy of 26.09.1997), acts regarding the state authorities supervising the work conditions (e.g. Act on State Sanitary Inspection), acts regarding OHS conditions in various areas of activity (e.g. Building Law), Polish Standards (PN). An additional source of obligations and rights regarding Health and Safety are OHS Rules, i.e. rules of safe conduct in performance of specific work not prescribed by the Polish law (extra-legal rules). OHS rules arise mainly from experience as well as technical and scientific premises.

According to the Building Law (chapter 3, Art. 20, 21a,1, 1a, 2, 3), the construction site manager is obliged to prepare or ensure preparation (prior to construction commencement) of a Safety and Health Protection Plan (SHP plan) for construction sites where it is projected that the construction works will be performed *for a period of time exceeding 30 days and, concurrently, at least 20 workers will be hired to perform them and the labour intensity of the planned works will exceed 500 man-days* as well as construction processes involving at least one of the types of works specified below:

- *The nature, organisation or performance site of which gives rise to a particularly high risk of origination of a threat to human safety or life, in particular a cave-in or fall from height*;
- *Performance of which is accompanied by effects of chemical substances or other biological factors posing a threat to human safety and life*;
- *Posing a threat of ionising radiation;*
- *Performed near high voltage lines or active communication lines;*
- *Positing a risk of drowning for the workers;*
- *Performed in well, underground and in tunnels;*
- *Performed by drivers of vehicles powered from overhead lines;*
- *Performed in caissons, with atmosphere produced from compressed air;*
- *Requiring use of explosives;*
- *Performed at installation and disassembly of heavy prefabricated elements*.

Thus, the purpose of the said SHP Plan is identification of all threats related to the works performed at the given construction site as well as determination of solutions to be implemented to prevent them during performance of works.

Based on the aforementioned document, safe works performance instructions, referred to as SWPI, are developed, the purpose of which is to inform about the methods of preventing threats related to the particular type of construction works (specified above) that require preparation of such a study. It is crucial that the provisions of SWPI are presented to and discussed with all workers performing the given type of works, being the subject of the given instructions.

BASIC OHS REQUIREMENTS APPLICABLE TO CONSTRUCTION WORKERS

Construction Site - place of origination of potential threats resulting, inter alia, from risk related to elements shown at fig. 2.1. (Note – fig. 2.1 – 2.19 – own source)

Fig. 2.1. Elements of risk on site.

<u>Prior to commencement of works at the construction site, it is necessary to determine the location (as shown at fig. 2.2.) of:</u>

- first aid and fire safety point,
- assembly point for evacuation,
- entrance to the construction site,
- construction site office.

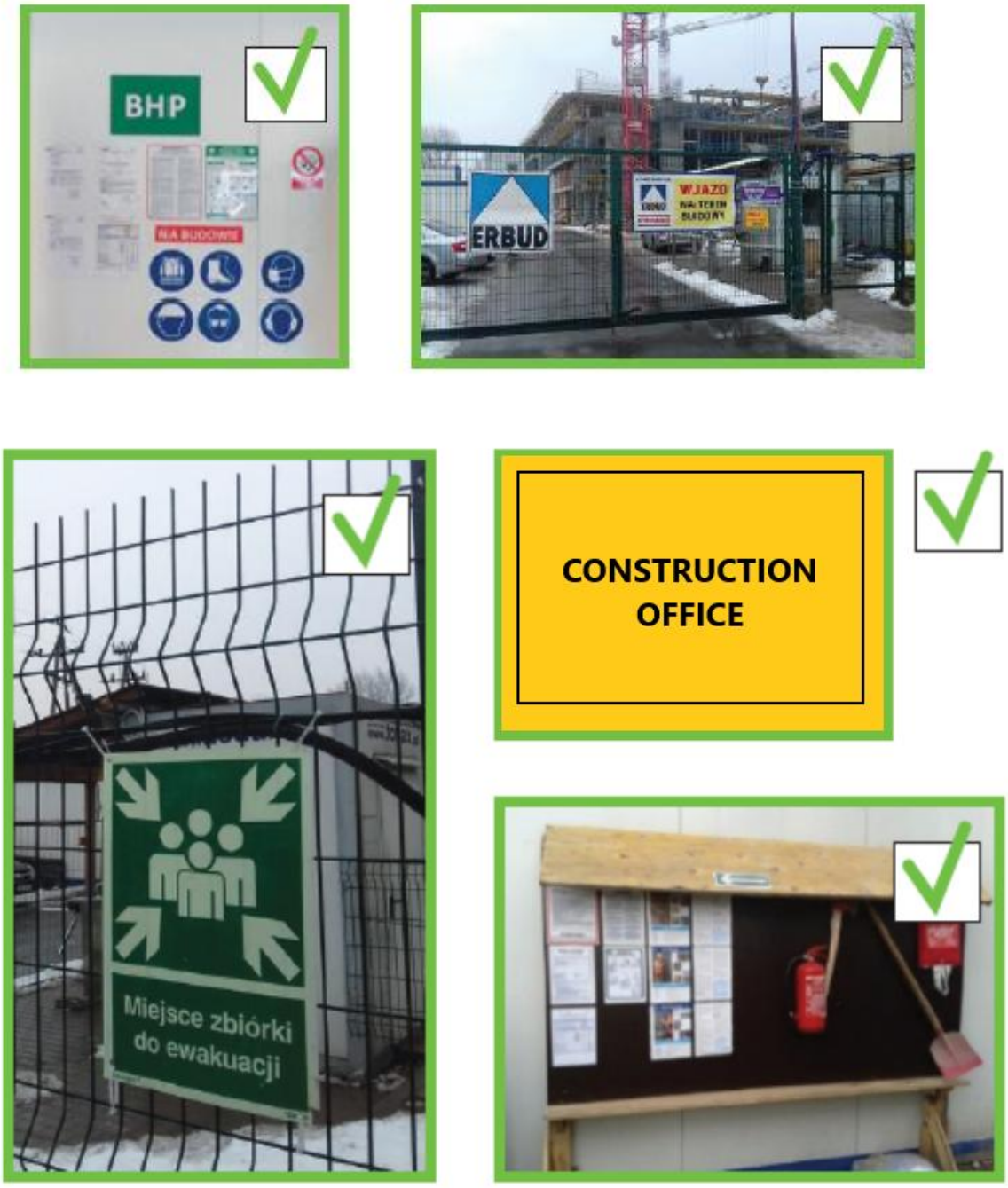


Fig. 2.2. Location of crucial construction site safety places.

The construction works can be commenced only after the following are provided:

- valid medical examination certificates,
- current OHS training (preliminary or periodical) ,most important elements of OHS training are shown in fig. 2.3.,
- current information training and station training at the construction site,
- required licences resulting from the type and nature of performed activities

Fig. 2.3. The most important elements of OHS training.

The following is required while performing works at the construction site (each of them is illustrated by the corresponding figure):

- Move only along the determined passage routes, do not block them with pallets, installation materials or other loads;

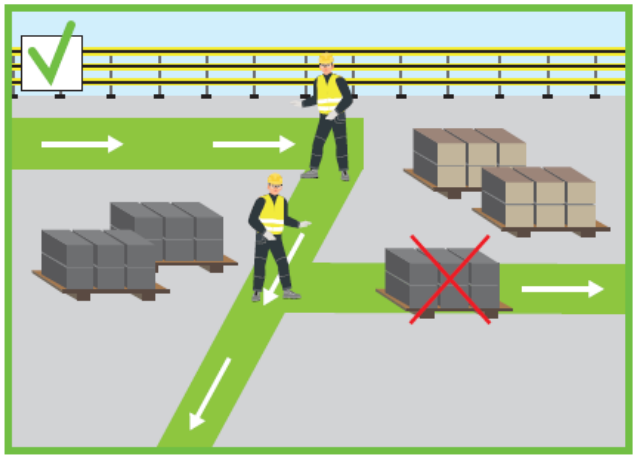


Fig. 2.4. Properly movement on construction site

- Perform all works according to the guidelines provided for in the SHP Plan, approved Safe Works Performance Instructions (SWPI) and only having obtained all permits required for the given works beforehand;

- Use only accepted scaffoldings, set up properly by authorised persons;

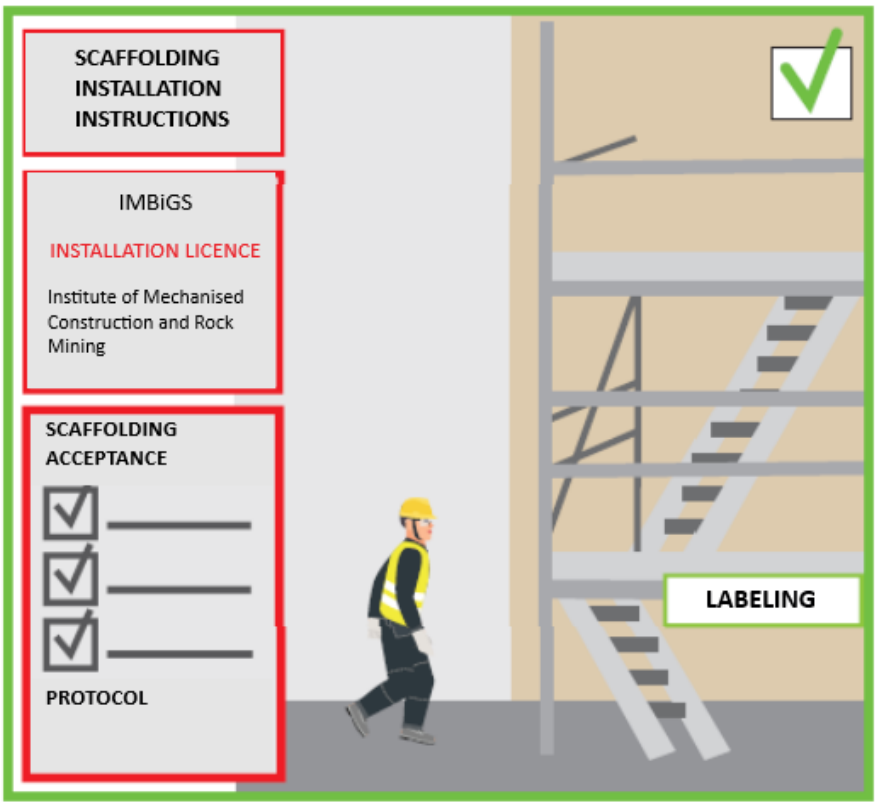


Fig. 2.5. Proper use of scaffoldings.

- Fence out hazardous zones (or report the lack of such fencing), e.g. in case of works at height, and do not enter the zones of other works performed in parallel;

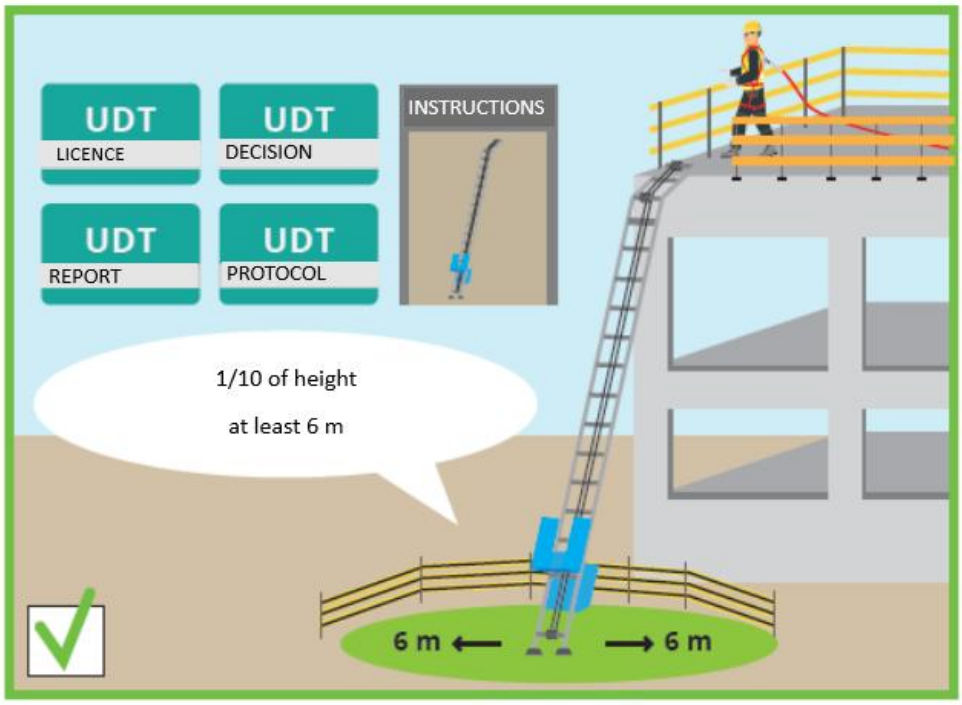


Fig. 2.6. Fencing out hazardous zones

- In case of works at height, use properly selected means of protection;

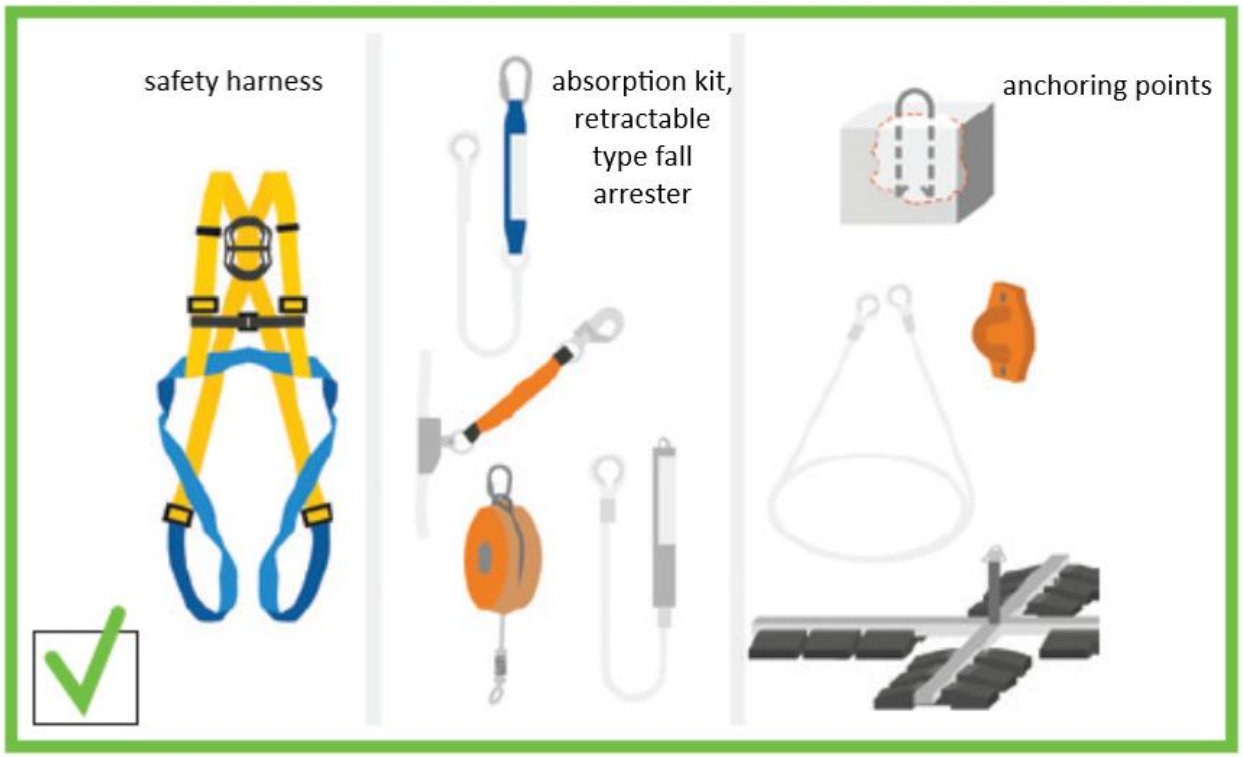


Fig. 2.7. Safety equipment.

- Use equipment meeting the relevant requirements, according to the manufacturer's recommendations provided for in the manual, in a good technical condition;

Fig. 2.8. Use equipment according to manual

- Observe the mandatory signs located at the construction site;

Fig. 2.9. Construction site mandatory signs.

- Observe the applicable prohibitions;

Fig. 2.10. Example of prohibition signs.

- Use personal protection equipment, proper for the nature of performed works;

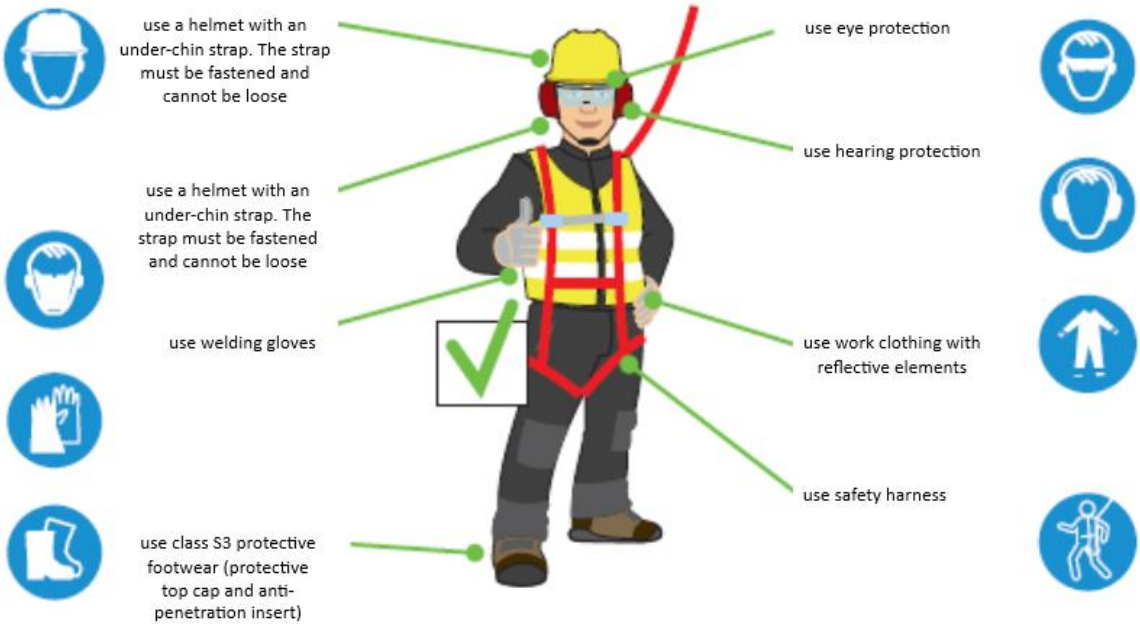


Fig. 2.11. PPE (Personal Protective Equipment)

- Keep the work site in order on a current basis;

Fig. 2.12. Keeping the work site in order.

- Store all elements in a manner excluding the possibility of tipping them off, them sliding down or apart or falling;

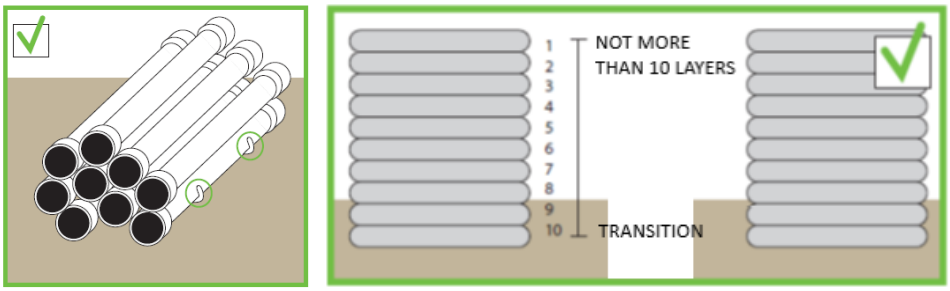


Fig. 2.13. Proper storage of materials.

2.2. Environmental protection

Performance of construction works, definitely including installation works, entails the necessity to meet specific requirements regarding Environmental Protection at the construction site.

The construction site supervision must provide as follows:

- Servicing the construction site provided by an enterprise holding proper licences for transport, collection and recovery of waste;
- Designation of waste collection and removal zones, according to the applicable sorting policies, i.e.:
  › building waste by type (rubble, wood, metal, paper, glass, plastic);
  › hazardous waste, according to the Safety Data Sheet of the given substance;
  › municipal waste connected with human presence by type for the dry fraction (paper, plastic, glass) and wet fraction (mixed waste);
- Relevant number of marked (descriptions, graphics) containers.

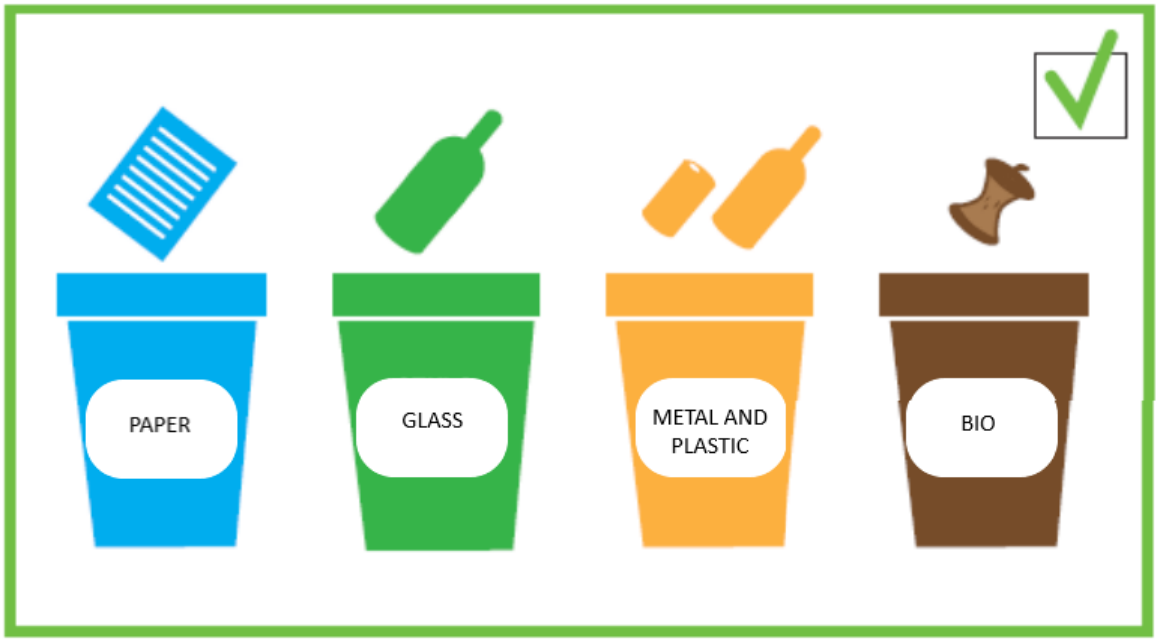


Fig. 2.14. Waste sorting containers.

REMEMBER!

At all construction sites, it is strictly prohibited to burn trash and mix hazardous waste with non-hazardous waste!

Fig. 2.15. Marking container for hazardous waste

In case of contact with hazardous waste, the following must be provided for the construction site:

- Tight and properly marked containers (information and warning signs) secured against effect of external factors;

- Organisation of ecological kits (e.g. sorbent – neutraliser) in case of leakage of a hazardous substance and training workers in terms of use of the said kits;
- Disposal of hazardous waste by an authorised company.

<u>In case of contact with chemicals – hazardous preparations, remember:</u>

- All substances must have a Safety Data Sheet and must be kept in original packaging or packaging with identification of the given substance;
- Use of a hazardous substance is allowed only after familiarisation with the said Safety Data Sheet and having equipped yourself with all protection equipment connected with safety of use of chemicals;

Fig. 2.16. Properly contact with hazardous substances.

- Preparations must be stored in a closed and ventilated room with a properly prepared ground;

Fig. 2.17. Correct and incorrect storage of preparations.

- All tanks with liquids must be marked.

Fig. 2.18. Marking liquids tanks.

REMEMBER!
Chemical leakage (including fuels and oils) is a hazardous waste!

In case of a fuel leakage, do the following as quickly as possible:

- *Secure the area against further uncontrolled spillage using containment measures (e.g. sorbet, sand, etc.),*

- *Secure gullies against penetration of the leakage,*
- *Remove the spillage using sorbets (according to the manufacturer's instructions)*

Compilation of basic rules of environmental protection at the construction site:

- Take care of clean water and do not pollute it. In practice, do not waste water and deteriorate the condition of the water stream;
- Operate the machines properly and prevent leakage/penetration of hazardous chemicals and oils, especially with regard to ground roads and near gullies;
- Maintain the machines and vehicles regularly;
- Take care of biodiversity and secure trees and animal habitats;

Fig. 2.19. Secure trees.

- Ensure proper fire safety protection measures, concurrently taking into account the possibility of ignition of materials which, in consequence, may result in environment pollution (water, air, etc.);
- Ensure proper protection against excessive dusting during construction works, both for the workers and third parties; Use anti-dust webs, e.g. sprinkling the areas exposed to dusting;
- Carry out activities related to electric energy saving, e.g. using energy saving lighting.

2.3. Construction workers' right and obligations

- Every works manager is obliged to familiarise himself (confirming it in writing) with the SHP Plan of the given construction site as well as the Safe Works Performance Instructions (SWPI) prepared based on the said plan and regarding the works performed by the given worker;
- The worker is obliged to observe the requirements and guidelines provided for both in the SHP Plan and the relevant SWPI;
- All workers must hold the following documents:

  - medical certificate regarding no contraindications to perform the entrusted works or holding the position, issued by doctor specialising in occupational medicine;

  - documents confirming validity of trainings in OHS and fire safety regulations, including the information OHS training conducted at the construction site prior to commencement of works, station training (workers hired on blue-collar positions must undergo periodical training at least once a year);

  - documents confirming qualifications necessary to perform the entrusted works, operate the equipment, drive the machines or vehicles;
- The worker must confirm in a protocol that he familiarised himself with the operating and maintenance documentation (OMD) of the machines and other devices as well as their operation manual.
- The worker is obliged to immediately report to the superiors or directly to the construction site manager any accidents, near-miss incidents and threats for health and life occurring at the construction site or related to it;
- The employer must provide the worker with work and protective clothing (including but not limited to the helmet and protective goggles, high visibility vest, etc.), work footwear as well as necessary personal protection equipment determined on the basis of the occupational risk assessment.
- Hygienic and sanitary as well as amenity rooms and equipment, including cleaning agents, must be provided to the worker according to the requirements of the law.

3. Technology (techniques, materials and tools)

3.1. Sanitary installations inside buildings

Modern and developed sanitary installations are becoming increasingly significant in all types of currently designed and constructed buildings.
Residential buildings with a single plumbing riser, gravity ventilation grill, bathroom with cold water and an electric heater as well as large, buzzing heaters attempting to cover the heat losses resulting from non-airtight windows or walls with hard to imagine heat transfer coefficients have already become a thing of the past.

Much higher expectations are set for the currently designed and constructed buildings. This results from new building standards and higher requirements for the installations in terms of their functionality, efficiency, durability or aesthetics. All that should take into account legal and practical requirements due to environmental protection, water and energy saving and, thus, broadly understood operating costs.

The role of the sanitary installation fitter in the building process is constructing the designed installations in such manner that completed installations fulfil their function and design assumptions in 100%. To achieve this effect, it is necessary to have general knowledge of the technologies applied in the sanitary installation sector as well as guidelines of the manufacturers of the particular designed and implemented system, to know how to read and apply sector designs as well as to have practical knowledge gained during work under the supervision of experienced foremen, engineers and managers of sector works.

Types of installations inside buildings

The basis of every building is its structure. However, depending on the building functions, the key elements include also sanitary installations:

- Ventilation, not discussed in this part
- Heating - most frequently as traditional radiator heating, but also floor heating or other types of heating devices
- Supply and distribution of water for household, fire extinguishing or technological purposes
- Storm water drainage system for collecting rainwater from roofs and terraces, replacing traditional gutters in larger buildings
- Sanitary and technological sewage system for collecting household sewage as well as wastewater from all production processes such as commercial preparation of meals
- Heating gas or other process gases, compressed air installations, etc.

3.2. Techniques, materials and tools related to heating installations.

In heating installations based on traditional, pipe distribution of heat, only seam or seamless, steel conductor pipes were used in places where higher durability was required (fuel transport, e.g. gas, or installations exposed to high pressures or mechanical stress - boilers, industrial sectors, etc.). This technology, as being verified, durable and economic, is still applied, but certain details related to workmanship have changed.
The technique of joining the steel pipes is based mainly on gas and electric welding as well as thread connections, and installation is still based on sliding supports and steel installation clamps.

Fig. 3.1. A part of the central heating installation constructed using the black steel pipe welding method (with anti-corrosive coating). Female thread bushes were welded at the raiser bifurcation for further development of the installation in a different technology at the riser branching. (Note: fig. 3.1 – 3.30 - Promotional materials of KAN-therm)

After installation and joining, steel pipes undergo pressure testing appropriate for the conditions of their future operation. During such test, the pressure of 1.5 times of the expected operating pressure is generated inside the installation and the pressure drop over a specific period of time is checked (no drop means the system is tight). After a successful tightness test, the entire installation is flushed to remove residues of materials or contamination from the pipes, such as welding chippings or sealing materials. Flushing of an installation constructed using the traditional technology is of particular importance as any solids left inside the pipes may clog small diameter ducts of heat exchangers or control fittings during further use, resulting in deterioration of operating parameters and, in extreme cases, even the necessity to repair the installation.

Together with technological progress, use of steel pipes in heating engineering has not been completely abandoned. Nevertheless, other competitive technologies are used in certain areas. The currently used materials (mainly plastics, but also specialist steel, copper, stainless steel or multi-layer pipes) have many advantages over the traditional steel pipe. The most important of them

include shorter time of installation, higher accuracy and cleanliness of works and lower weight of the pipes themselves as well as tools and devices used in the assembly process. Despite high price of such materials, continuously increasing of labour costs make their use convenient and cost-efficient in the long run.

3.2.1. Polypropylene systems with welded joints.

The plastic most commonly used in construction of pipe systems in, inter alia, heating installations is **polypropylene (PP)**.

Fig. 3.2. A part of PP system.

Polypropylene is a thermoplastic plastic from the polyolefin group and is one of two (the other being polyethylene) most commonly used plastics. Pipes and fittings are produced using polypropylene copolymer (Polypropylene Random Copolymer) (PP-R).

Polypropylene is characterised by:

- high hygiene of products (microbiological and physiological neutrality) - it can be used in installations for potable water,
- high chemical resistance.
- resistance to corrosion,
- low thermal conductivity (high thermal insulation of the pipes),
- low specific gravity,
- resistance to scaling,
- absorption of vibrations and flow noises,
- mechanical strength,
- homogeneity of connections,
- long life and durability.

In addition to the above advantages, polypropylene has also two major disadvantages. Due to its elasticity, ensuring the required product durability, PP elements must have thicker walls than elements made from other materials - thus, the outer diameters of the pipes and fitting sizes are large. That reduces the possibility of PP pipes application in places with limited installation space (in wall grooves or in the flooring). Another disadvantage of PP is quite high thermal expansion. Due to this feature, in addition to homogeneous products made from polypropylene, products stabilised (reinforced) with metal tapes or mineral fibres are also used. Despite that, the designed PP installations must be constructed with multiple thermal expansion compensation spots. The above disadvantages actually determine the area of application of this material as intended for ceiling and shaft installations, but they do not exclude its use in, for instance, installation walls, provided that enough space is ensured.

There are 3 types of polypropylene pipes available on the market:

- homogeneous,
- stabilised with aluminium foil, the so-called Stabi Al,
- stabilised with glass fibre, the so-called Glass.

An example of an installation system based on bonded pipes is KAN-therm PP Stabi Al (manufactured by KAN-THERM), consisting of a homogeneous base pipe made of polypropylene PP-R, coated with 0.13 mm thick, perforated aluminium foil, connected using the overlapping technique and additionally coated with a protective layer of polypropylene. For better binding of aluminium and polypropylene, special adhesive layers are applied on both sides.

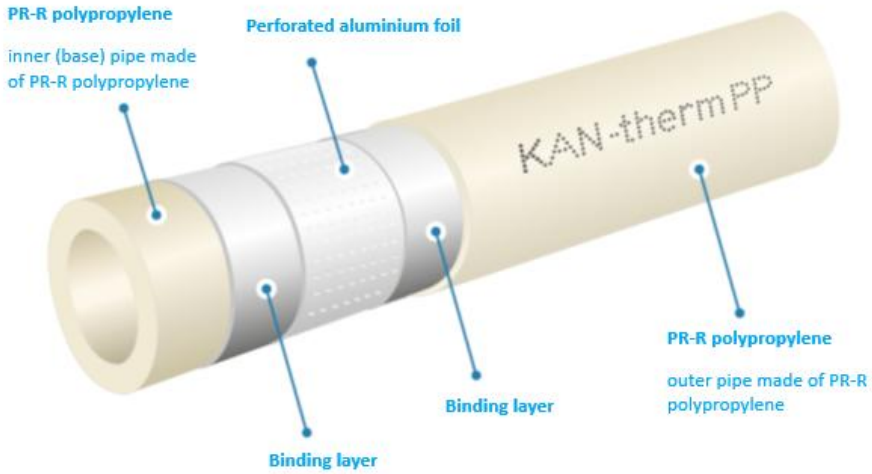


Fig. 3.3. Cross-section of a KAN-therm PP Stabi Al pipe.

The basic role of the aluminium insert into KAN-therm PP Stabi pipes is significant (five times) reduction of thermal expansion of the pipes in comparison to pipes made of solid PP. The aluminium layer with lower thermal expansion takes over the stress from the expanding under the impact of temperature PP, reducing the effects of temperature on the pipe and provides partial protection against oxygen diffusion from the environment.

KAN-therm PP Glass pipes (another example of systems produced by KAN-THERM) have multi-layer structure. The difference is in the reinforcement as, instead of the aluminium, glass fibre is applied, as a middle layer (40% of the pipe wall thickness). It makes the pipe highly durable and reduces its thermal expansion. In this case, the parameter is slightly worse than for the PP Stabi Al system.

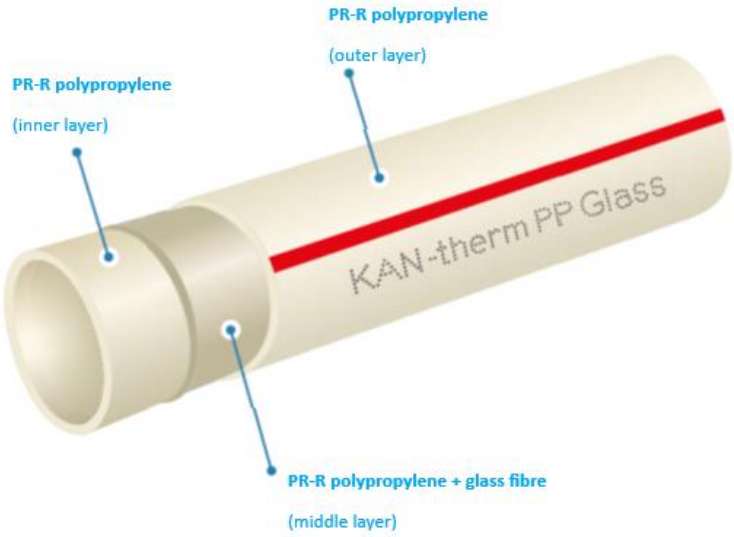


Fig. 3.4. Cross-section of a KAN-therm PP Glass pipe.

Dimension and pressure classification of PP-R pipes

Currently, there are three different methods of classification of polypropylene pipes:

- Pressure classification PN (Pressure Nominal), referring to the resistance to pressure expressed in bars [bar] in temperature of +20 ^{o}C,
- Dimension classification SDR (Standard Dimension Ratio), as a dimension interval expressed as the ratio of the outer diameter to the pipe wall thickness

$$SDR = D / s$$

- Pipe dimension classification S, as a dimension series expressed as the outer diameter less the pipe wall thickness in relation to the double thickness of the pipe wall (see Table 3.1)

$$S = (D-s)/2s$$

Table 3.1: **PP-R systems include diameters ranging from 16mm to 110mm.** (It must be noted that in the case of pipes made of plastics, the outer diameters of the pipelines and, as the second parameter, the wall thickness of the given pipe (value in millimetres) are always specified).

PN	SDR	S
10	11	5
16	7.4	3.2
20	6	2.5

Example specification of diameters for the KAN-therm PP PN20 Stabi Al (S2,5/SDR6) system is shown in Table 3.2.

Table 3.2: Specification of diameters for the KAN-therm PP PN20 Stabi Al (S2,5/SDR6) system

Dimensions [mm]	Outer diameter D [mm]	Wall thickness s [mm]	Inner diameter Di [mm]
16 × 2.7	16 (17.8)	2.7	10.6
20 × 3.4	20 (21.8)	3.4	13.2
25 × 4.2	25 (26.9)	4.2	16.6
32 × 5.4	32 (33.9)	5.4	21.2
40 × 6.7	40 (41.9)	6.7	26.6
50 × 8.3	50 (51.9)	8.3	33.4
63 × 10.5	63 (64.9)	10.5	42.0
75 × 12.5	75 (76.9)	12.5	50.0
90 × 15.0	90 (92.0)	15.0	60.0
110 × 18.3	110 (112)	18.3	73.4

The operating parameters and scope of application of the KAN-therm PP installation in heating and water pipeline systems are presented below (in Table 3.3):

Table 3.3: Operating parameters and scope of application of the KAN-therm PP installation in heating and water pipeline systems

Application According to ISO 10508	Operating pressure [bar]	Pipe type
Cold utility water	According to the pipe pressure class	PN16, PN16 Stabi Al, PN16 Glass PN20, PN20 Stabi Al, PN20 Glass
Hot utility water (class 1) T / Tmax = 60 / 80 °C	10	PN20, PN20 Stabi Al, PN20 Glass
	8	PN16, PN16 Stabi Al, PN16 Glass
Hot utility water (class 2) T / Tmax = 70 / 80 °C	8	PN20, PN20 Stabi Al, PN20 Glass
	6	PN16, PN16 Stabi Al, PN16 Glass
Low temperature and surface heating (class 4) T / Tmax = 60 / 70 °C	10	PN16, PN16 Stabi Al, PN16 Glass PN20, PN20 Stabi Al, PN20 Glass
Radiator heating (class 5) T / Tmax = 80 / 90 °C	6	PN16 Stabi Al, PN16 Glass, PN20, PN20 Stabi Al, PN20 Glass

Polypropylene fittings (based on the example of the KAN-therm PP System)

They are made of an identical PP-R material, with no additional reinforcement, and in the series PN20/SDR6. This parameter configuration ensures the fitting being at least equal to the connected polypropylene pipes in terms of pressure resistance.

Fig. 3.5. Examples of KAN-therm PP fittings

Due to its low hardness, polypropylene is not suitable for threaded elements. Therefore, threaded joints are based on prefabricated fittings with PR-R bodies and embedded, threaded brass elements.

Fig. 3.6. Examples of KAN-therm PP fittings with threaded inserts (the so-called "adapters")

In case of larger installation diameters, the split couplings are based on steel flanges pressing the fragments to each other - the sealing is the flat gasket compressed between the pipes.

Fig. 3.7. PP/flange "adapter" fitting

Installation of joints in PP pipe systems (based on the KAN-therm instructions)

Welding is the basic polypropylene pipeline joining technology. This process consists of melting the layers of joined elements (to a certain depth) using increased temperature, then joining partially melted layers under proper pressure, and finally cooling the area of joined elements under the melting temperature. Melting of joined layers takes place in temperature of ca. 260 °C over the specific time, taking into account the need to heat up the material layer up to a specific depth. Ensuring proper conditions of this process, such as temperature, time, force and area of pressure as well as proper preparation of joined elements (cleaning, degreasing and drying), guarantees proper joining of connections (durability, strength).

Fig. 3.8. Cross-section of joints in a PP system

The most commonly applied method of welding of polypropylene elements is the polyfusion welding technology consisting of melting the outer surface of the pipe and internal surface of the fitting up to a specific depth. This action is performed using an electric welding machine with a heating plate with replaceable (for the given diameter), Teflon-coated heating tips (the so-called "stones").

Fig. 3.9. PP system welder

Heating the elements takes from 5 to 50 seconds, depending on the pipe diameter. Subsequently, the heated elements are taken out of the heating plates and the pipe is immediately slid (without rotary motions!) into the pipe coupling, up to the previously marked depth. **The mechanical strength of this joint, if made correctly, is higher than the strength of the pipe itself (the area of the cross section of the joint is larger than the area of the pipe cross section).**

Polyfusion welding process

1. Pipe cutting.

Fig. 3.10. PP pipe cutting.

Pipe cutters and (for larger diameters) rotary pipe cutters or mechanical saws with saw blades adjusted to polypropylene can be used to cut the pipes. If a saw was used in the cutting process, the chips must be removed both from the cut surface and from the inside of the pipe. **The pipes must be cut perpendicularly to the axis.**

2. Marking the welding depth.

Fig. 3.11. Marking the welding depth on a PP pipe.

Mark (using a measure, template and a marker) the weld depth (applies to homogeneous pipes and Stabi Glass) at the end of the pipe. Remember that too low welding depth may result in weak joints, whereas if the pipe is inserted excessively deep that may cause excessive narrowing of the pipe. The welding depths are specified in the Manufacturer's table.

3. Removal of the Al foil (applies to systems with aluminium inserts).

Fig. 3.12. Removal of the aluminium foil from PP pipes.

In case of bonded Al pipes, the aluminium layer (together with the PP protective layer and binding layers) must be removed. Slide the end of the Stabi pipe into the opening of the pipe scrapper and scrap aluminium layer using rotary motion until no more chips can be obtained. The length of the section with removed Al foil concurrently determines the welding depth. Therefore, it does not have to be marked as it was described in point 2 above. Each time it must be checked whether the surface does have any remains of aluminium or a bonding layer. Cutting blades cannot be blunt or notched (replace used blades with new ones).

Note! Extend the heating time by 50% at external temperatures below +5 °C .
At temperatures below zero, protect the welding place against additional cooling, e.g. by means of screens or protective tents. In the case of PP Glass pipes (bonded pipes with glass fibre), it is recommended to cut ca. 5 cm of the end of each bar immediately before use.

4. Heating pipe and fitting.

Fig. 3.13. Welding the pipe with the elbow fitting in the PP system

Welded surfaces must be clean, degreased and dry. Insert the end of a pipe (without turning) to the heating sleeve up to the marked welding depth and slide a fitting (also without turning) onto the heating tip. Heating time begins to run only when the pipe and the fitting are inserted in full depth (welding depth). In the case of PN10 thin-walled pipes, firstly only the fitting is heated (holding the heating plate on the other side with an object resistant to high temperatures). In a halfway of the heating time (according to the table) start to heat the pipe and continue to do so until the end of the heating time, heating the fitting simultaneously.

5. Elements connection.

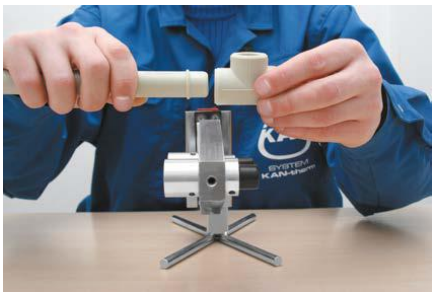


Fig. 3.14. Joining the pipe with the elbow fitting in the PP system

After the heating time has elapsed, pull uninterruptedly the pipe and the fitting out of the heating stones and connect them immediately without turning until the marked welding depth is covered by the excessive amount of material that emerges (Do not exceed the marked welding depth: otherwise a narrowing can appear in the joint or, in extreme cases, the pipe may close). During joining elements, the joint can still be axially slightly adjusted (within several degrees). In any case do not turn the joined elements in relation to each other.

6. Immobilisation and cooling.

Fig. 3.15. Immobilising the pipe with the elbow fitting in the PP system

After the welding time, the joint must be immobilised, and then the cooling time starts (according to the proper table provided with the given system). After the cooling time for all joints has elapsed, the system should be filled with water and a pressure test should be carried out.

PP pipeline installation

PP pipelines are installed in construction partitions by means of metal clamps with elastomer inserts and by means of plastic clamps. Their structure depends on the diameter and the pipe type, operating parameters of the system and the manner in which it has been installed. Use plastic clamps as sliding points only. Metal clamps with elastomer insert can be used both as sliding and fixed points.

Note! Metal clamps without elastomer inserts must not be used to fit polypropylene systems due to the risk of their damage.

Fig. 3.16. Fitting handles (in order): metal clamp with elastomer insert and plastic clamp

The abovementioned sliding points should allow free axial movement of pipelines (caused by thermal expansion), so they should not be fitted directly next to fittings. Fixed points on the pipeline must be made by using two clamps adjacent to the edge of the fitting (T-connector, connector, coupler) or one clamp placed between couplers / fittings (fig. below). A fixed point is usually made near bifurcations of pipelines or sanitary fixings. Alternative solutions for fixed points are allowed provided that the force used for tightening the clamp ensures no axial movements of pipelines and protects system pipes against mechanical damage.

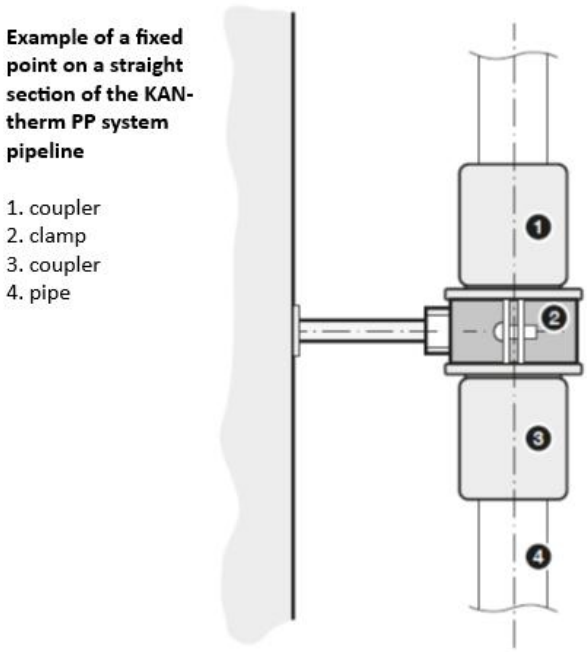


Fig. 3.17. Example of fixed point - clamp between couplers.

NOTE! The arrangement of fixed points results from the adopted solution for compensation of thermal expansions in the system and should be determined in the technical design. The designer takes into account the system type and adopts calculation temperatures of pipelines using guidelines issued by the manufacturer of the given system (the product sheet).

Transport and storage

- Store and transport the pipes in vertical position so that they cannot bend
- Do not store the pipes near strong heat sources.
- Protect the pipes against impact, particularly their tips, do not throw them, do not drag them during transport
- The pipes and the fittings cannot be exposed to sunlight
- Do not use pipes with signs of damage, cracks etc.
- Proceed with caution during transporting and handling the pipes at temperatures below 0°C (this is when the pipes are more exposed to mechanical damage, in particular PP Glass pipes).
- Protect the pipes and the fittings against contamination (particularly with oils and lubricants) and against chemicals (e.g. organic solvents and paints, chlorine-containing vapours).

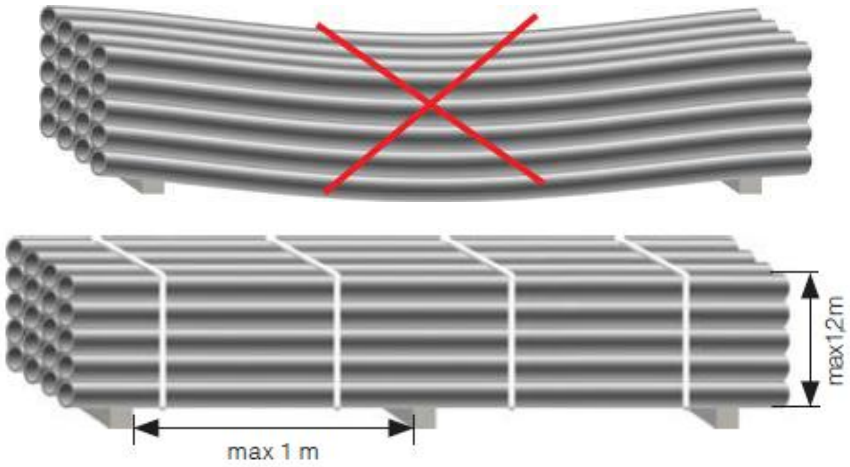


Fig. 3.18. Incorrect and correct storage of PP pipelines.

The continuous increase of labour costs in construction processes leads to increased popularity of steel pipe systems with system joints. This allows reducing the time needed to prepare the system by way of replacing threaded and welded joints with clamping/pressing coupling and simultaneously maintaining the standard and all advantages of a system made of steel.

3.2.2. Systems made of externally galvanized carbon steel with clamp connections.

An example of such a system is, inter alia, **KAN-therm Steel** (prod. by KAN-therm) based on clamping fittings and pipes made of carbon steel externally galvanised with a layer of 8 to 15 µm and additionally protected with a passivation layer of chromium. For transport purposes, the pipes are protected against corrosion with a hot-applied thin oil film inside and closing plugs.

Fig. 3.19. KAN-therm Steel system

Steel pipes are prepared as thin-walled pipes with a longitudinal seam. External diameters range from ø12 to ø108 mm with the wall thickness from 1.2 to 2.0 mm – due to the absence of threading, thin-walled pipes can be used; they are much lighter than the traditional steel pipes. The pipes are provided in straight, 6 m long (± 25 mm) sections (bars) (look at Table 3.4).

Table 3.4: Steel pipes dimensions

DN	Outer diameter x wall thickness mm × mm	Inner diameter mm × mm
10	12×1.2	9.6
12	15×1.2	12.6
15	18×1.2	15.6
20	22×1.5	19.0
25	28×1.5	25.0
32	35×1.5	32.0
40	42×1.5	39.0
50	54×1.5	51.0
-	66.7×1.5	63.7
65	76.1×2.0	72.1
80	88.9×2.0	84.9
100	108×2.0	104.0

NOTE! In case of a system made of steel, the executive design determines the diameters nominal (DN) i.e. non-dimensional numbers corresponding to the approximate value of internal diameter of a pipeline provided in millimetres.

Fittings pressed in the KAN-therm Steel system

Fig. 3.20. KAN-therm Steel system fittings

The KAN-therm Steel system fittings are made of the same material as the pipes. System elements are joined by radial pressing with clamping jaws or clamps in the “M” profile (tightening contour). A joint is characterised by the following squeezing points of fitting material:

- mechanical deformation of the body of a fitting and a pipe for mutual jamming of the elements.
- pressing an O-ring between the body of a fitting and the external surface of a pipe (joint sealing).

- mechanical deformation of the front of a fitting – protection of O-ring against environmental factors.

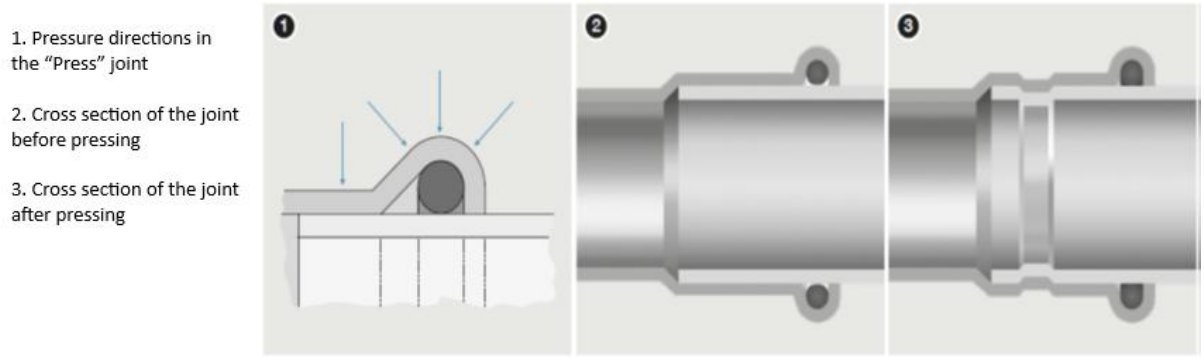


Fig. 3.21. Cross-section of a joint in the KAN-therm Steel system

The discussed Steel fittings are normally equipped with O-rings made of ethylene propylene diene monomer EPDM. For special applications, it is possible to use Viton O-rings with increased resistance to operating conditions.

If additional sliding agent is necessary (standard O-rings are coated with Teflon and talc), use water or soap. **Do not spread fat, oil or grease on O-rings. These substances may damage the sealing.** This also applies to contact with some paints used to paint pipes and fittings.

KAN-therm Steel fittings up to the diameter of DN 50 (outer diameter 54 mm) are equipped with special LBP O-rings, which guarantee quick detection of system joints that have not been accidentally clamped just when water is introduced in the system (LBP – Leak Before Press). Incorrect clamp will be noticed due to a water leak at a joint. This feature results from the special design of O-rings, which have 3 recesses on their periphery. To ensure functionality and full tightness of the system, after a leak is detected, the joint must be pressed. For joints with diameters exceeding DN 50, the LBP feature is obtained by proper structure of the fitting.

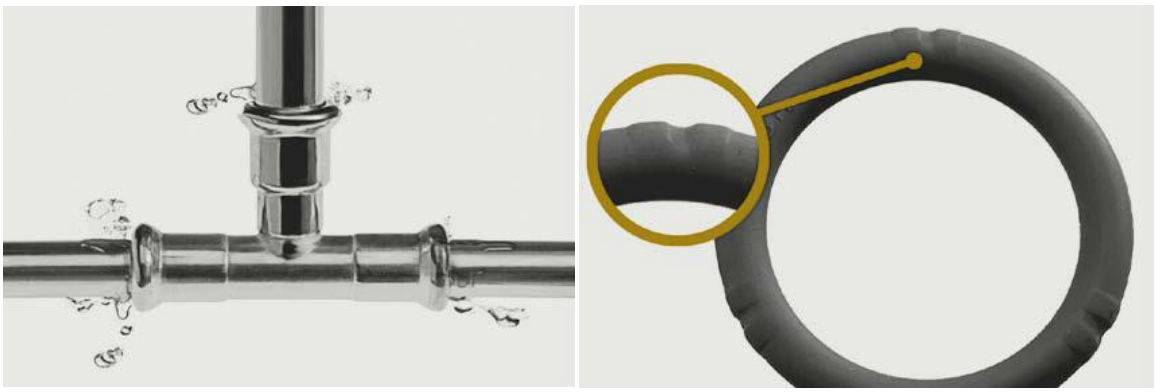


Fig. 3.22. System for detection of not pressed joints with controlled leakage.

In order to make split couplings with fittings and accessories, threaded and flanged fittings can be used in a wide range of diameters, commonly called as “adapters.”

Fig. 3.23. Adapting fittings (for threaded and flanged coupling).

Fitting the joints in the STEEL system

NOTE! All installation stages are to be carried out without increased temperature (“cool” installation).

1. Pipe cutting

Fig. 3.24. Cutting the KAN-therm Steel system pipe

Cut a pipe perpendicularly to its axis, using a specialised rotary pipe cutter **(the cut must be complete, without breaking the cut pipe sections).** It is admissible to use other tools, provided that the cut is perpendicular and the cut edges are not damaged in the form of breakaways, material loss and other deformations of a pipe cross-section.

NOTE! Thin-walled carbon steel pipes cannot be cut by tools that can generate considerable amounts of heat, e.g. blowpipe, angle grinder etc.

2. Pipe edge chamfering

Fig. 3.25 Chamfering the edges of Steel pipes after cutting.

To chamfer the edges of cut pipes, use a chamfering device or a semi-circular steel file. Chamfering must include the external and internal part of the tip of the cut pipe. Thanks to such a procedure, any splinters, irregularities and filings are removed which could damage an O-ring during joining.

3. Pre-joining check:

Fig. 3.26 Pre-installation check of the fitting

Before installation, check visually for:

- proper placement of the O-ring in the fitting,
- any surface damage of the O-ring,
- proper selection of the O-ring for the planned use,
- any contamination (filings or other sharp materials) that could damage the O-ring while the pipe is being inserted;

4. Pipe and fitting connection

Fig. 3.27. Pipe and fitting connection.

Insert the pipe axially to the marked depth. You can rotate it slightly for precise set. **Use of oil, grease and fat to facilitate insertion of a pipe is prohibited (soap solution or water are allowed).** In the case of simultaneous installation of many joints (by inserting pipes in fittings), control the insertion depth before the pressing of each connection (observation of marks on the pipe applied with a marker pen).

5. Marking the depth of insertion of a pipe in a fitting

Fig. 3.28. Marking the depth of insertion of a pipe inside a fitting.

To obtain proper durability of connection, maintain proper depth of insertion of a pipe into a fitting. After a pipe is inserted in a fitting until the end, mark the required insertion depth on a pipe (or a fitting with a bare end) with a marker pen. After pressing, the marking must still be visible just at the edge of the fitting. To determine the insertion depth without adjusting to fitting special templates may be used.

6. Pressing the joints

Fig. 3.29. Pressing the joints of various diameters

It is recommended to use a press tool and pressing jaws checked before use, delivered or approved by the manufacturer of given system.

NOTE! Before pressing the joints, read the manual of the tools. Select the size of the pressing jaw adequate for the given diameter of joint. The pressing jaw should be placed on a fitting so that its profiling tightly covers the place where the O-ring is put in the fitting (the convex part of the fitting). After the pressing tool is turned on, the pressing process starts automatically and cannot be stopped. If for any reason the pressing process is stopped, the joint must be removed (dismounted) and a new one must be prepared correctly.

Fitting KAN-therm Steel pipelines

To mount the pipes of the KAN-therm Steel system to construction partitions, metal clamps with elastomer inserts are used. Their structure depends on the diameter and material of the given pipe, the operating parameters of the system and the manner in which it has been installed. Metal handles with elastomer insert can be used both as sliding and fixed points (depending on their placement on the pipeline and the tightening force).

NOTE! Metal clamps without inserts may damage galvanised surfaces, so they must not be used.

The manner in which sliding and fixed points are made has been discussed for other pipe systems and it can be used in this case as well. Similarly to all other materials, the technical design must include at least the placement of fixed points and their structure in special cases (e.g. long distance from immovable structural elements of a building).

Pipe systems made of thin-walled carbon steel, despite corrosion-protection layers, are intended for surface-mounted installations. Installing the systems in the flooring and walls is not recommended due to increased risk of external corrosion.

NOTE! Direct connection of carbon steel elements with stainless steel, aluminium or copper (fittings and couplings) may lead to contact corrosion of galvanised steel. To avoid the above phenomenon, use a brass or bronze separator (e.g. fittings) with the length of at least 50 mm. In the case of larger system diameters, it is enough to use flat elastomer sealing between the flanges.

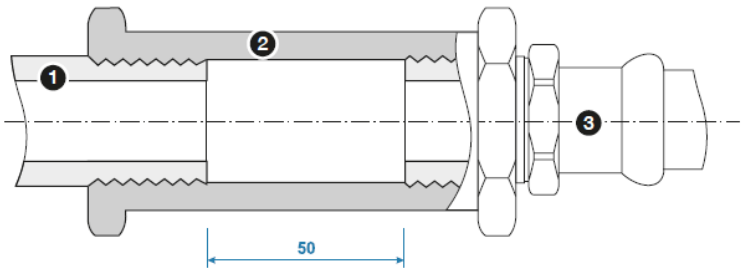


Fig. 3.30. Joint between the Steel system and a system made of copper/stainless/aluminium pipes where:

1. Stainless steel, copper or aluminium pipe
2. Brass or bronze coupler
3. Threaded fitting of the KAN-therm Steel system

Transport and storage

- Steel system elements (carbon steel) and other metal elements must be stored separately,
- It is inadmissible to store elements directly on the ground (e.g. on the soil or concrete),
- It is prohibited to store chemicals in close proximity,
- Bundles of pipes must be stored and transported on wooden spacers,
- Make sure that during storage the pipes are equipped with original closing plugs or, eventually, that their tips are secured with polyethylene foil,
- During transport, loading and unloading, do not allow any scratching or mechanical damage to the pipes and the fittings,
- The rooms where the elements are stored must be dry (the elements cannot be stored outside in the long term).

3.3. Techniques, materials and tools related to water installations.

At the same time, what a black steel has been for heating systems, galvanised steel pipe has been for potable water. The reliable and verified material with high rigidity and resistance to high pressure with reliable and verified joints (threaded mostly) can be processed and installed with simple and reliable tools. However, the knowledge and technology has been in progress. The first step, was to withdraw the use of galvanised steel pipes in water systems due to their internal roughness, susceptibility to scaling and weight, which made installation more difficult. New technologies were much more beneficial in this respect – PP or Pe pipes, smooth inside and outside, are light and easier to process, they can be shaped and placed in floorings or wall grooves, so they conquered the market easily. Moreover, in hot water systems the galvanisation layer in steel pipes was easily washed away. As a result, the pipes were no longer resistant to internal corrosion and started to be prone to failures. Plastic pipes ensure stable performance for many years and inside scaling is minimal, so they do not have to be resized for deterioration over time.
Use of galvanised pipes in modern systems is actually limited to large-diameter systems for distribution of cold potable water and water systems for fire protection purposes (the pipe and the joints are fully non-inflammable) or for process-related purposes. Systems adapted to use in cold and hot household water are currently based on polypropylene, polyethylene and stainless steel.

3.3.1. Systems made of galvanized steel with threaded or grooved connections.

Despite a continuous tendency to reduce the share of **galvanised pipes** system in all installed **household water systems**, it is worth to tell more about this group of materials.
Steel pipes are used here, protected against external and internal corrosion with a protective layer of zinc.
The most popular method for installing individual sections of galvanised pipes and fittings of water supply systems is the use threaded joints. This leads to the necessity to increase wall thickness and, in turn, the weight and rigidity of the material. Therefore, making water systems of galvanised steel pipes requires a lot of work.

DESCRIPTION OF INSTALLATION OF THREADED JOINTS

1. Cutting the galvanized pipe.

Pipes are cut with electric angle grinders with a suitable disc for cutting steel, reciprocating saws, electric cutters for pipes and with manual methods, by means of a hand saw with a blade. The pipe should be cut perpendicular to its axis. After the pipe is cut, any burrs along the internal edge should be removed (deburred) with a file or a deburrer.

2. Threading the pipe.

First, a pipe should be placed in a vice to stabilise it before threading. Subsequently, a thread should be cut with manual adjustable threaders, manual threaders with removable heads, electric threaders with quick-change heads or special stationary machines for pipe threads which cut threads in the range from 1/2 to 4”. During the process, the thread surface should be moisten with a coolant. For this purpose, oil or specialised cooling emulsion is used. The thread surface must be clean free from any burrs or damaged coils. Incomplete and broken thread coils are allowed up to 10% of the entire thread length.

3. Connecting pipes using threads.

Galvanised steel pipes are joined with an external thread on the pipe and an internal thread in the connectors, which are screwed onto the ends of the pipes to be joined. Before putting the sealing material onto the thread surface, the thread must be blunted e.g. with a saw blade or a specialised device – the so-called flint. This procedure increases grip of the thread surface for the sealing material and, in turn, prevents the sealing material from being pushed out of the joint when the fitting is screwed onto the thread. Hemp strands with sealing paste (between individual layers of strands and on the external surface of the sealing material) or special Teflon tapes are used as sealants. The sealant must be wound tightly so that it does not unwind when the fitting is being screwed on the thread.

Initially, the fitting is screwed on manually and, subsequently, with a special pipe wrench. This prevents damaging the external galvanised coat.

Fig. 3.31. A part of a water supply system consisting of galvanised pipes with threaded joints The valve armature of wider diameters is connected with pipelines by flanged joints.

Fig. 3.32. A part of a water supply system connected with threaded joint (on the left) and a flanged one

The so-called grooved pipe coupling is becoming more and more popular method of joining galvanised water supply pipes. Despite a higher price of individual elements of those systems (compared to threaded connections), the speed of such joints preparation and disassembly process make them being used by installation companies more and more often.

Photo 3.33. Parts of water supply systems consisting of galvanised pipes connected with grooved and threaded joints, part a. (own source)

Photo 3.34. Parts of water supply systems consisting of galvanised pipes connected with grooved and threaded joints, part b. (own source)

Advantages of installation of galvanised water supply pipes:

- high rigidity and, in turn, lower number of fitting points,
- low thermal expansion (compensation is required only for longer sections),
- high compression and tensile strength,
- resistance to high pressures.

Disadvantages of installation of galvanised water supply pipes:

- coating with protective layers which can be easily damaged when threading, screwing, transporting and storing
- the shortest life among all systems intended for water supply
- dramatically increased susceptibility to corrosion when exposed to softened water,
- high roughness index, which increases hydraulic resistances leading to intensified scaling and deposition of sediments on internal walls (reduction of the operative cross-section of pipes),
- gradual dissolution of the internal galvanisation layer leading to water contamination.

3.3.2. Systems made of stainless steel with press connections.

A group of water systems installation using press connections are systems of pipes made of stainless steel. The material combines the best mechanical features of traditional steel pipes with performance of plastic pipes (easy to process, smooth, physicochemical inert, resistance to corrosion). Thanks to these features, pipes and fittings made of stainless steel are used more extensively, covering not only heating systems (as it is in case of the Steel system) but also household water systems as well (hot water, cold water).

An example of such a system of **Kan-therm Inox** (made by KAN-therm)

Fig. 3.35. KAN-therm Inox system (Promotional materials of KAN-therm)

Kan-therm Inox pipes are made as thin-walled pipes with a longitudinal seam in a range of external diameters, from ø12 to ø168 mm, with wall thickness from 1.0 to 2.0 mm. The pipes are provided in straight, 6 m long (± 25 mm) bars (look at Table 3.5).

Table 3.5: Kan-therm Inox pipes dimensions.

DN	Outer diameter x wall thickness mm × mm	Inner diameter mm × mm
10	12 × 1.0	10.0
12	15 × 1.0	13.0
15	18 × 1.0	16.0
20	22 × 1.2	19.6
25	28 × 1.2	25.6
32	35 × 1.5	32.0
40	42 × 1.5	39.0
50	54 × 1.5	51.0
65	76.1 × 2.0	72.1
80	88.9 × 2.0	84.9
100	108 × 2.0	104.0
125	139.7 × 2.0	135.7
150	168.3 × 2.0	164.3

As already mentioned, Kan-therm Inox uses the same press joint system (based on O-rings) as the Kan-therm Seel. Therefore, the installation process is the same. Transport and storage also follow the same basic principles.

3.3.3. PE-X and PE-RT multilayer systems.

The greatest progress in terms of available solutions may be observed definitely in single-family housing systems and individual flats of multi-family buildings, blocks or public buildings. To distribute internal water and heating sanitary systems, modern plastic pipe systems, metal pipes and multi-material pipes (the already described PP and thin-walled steel) are used. For the purposes of space saving and aesthetics of rooms, pipe systems in rooms are installed in floorings and/or wall grooves and system spaces (shafts and spaces above suspended ceilings); less often on the surface. In terms of water and heating systems, the most commonly used pipes are multi-layer pipes made of PE-X or PE-RT polyethylene.

Due to the variety of proposed technologies, several basic products must be focused on that are used most commonly under different brand names depending on their manufacturers and production lines. Importantly, nearly all of the proposed materials have the required approvals and are versatile for heating and potable water systems (hygiene certificate for use in potable water supply systems). Therefore, distribution of the system can be carried out with the same materials that have been used for all systems in the room.

However, special attention should be paid to the fact that due to small differences in the structure of systems and suggested connection fittings or fraction-millimetre differences in pipe wall thickness, systems made by different producers are not compatible with each other and they can be connected only with standardised threaded joints or system solutions approved by particular manufacturer.
Solutions and work specification for the central heating and potable water supply systems are presented below on the basis of products made by TECE – a recognized producer on the European market. Depending on the manufacturer, work procedures may be slightly different, but the basic principles and the necessity to follow the technological regime are universal.
Multi-layer PE-X or PE-RT pipes are joined in two ways – with bushes clamped at the joint, the so-called radial joint, or sleeves slid on the joint, the so-called axial joint. In case of the axial joint, the entire joint surface is sealed – the pipe wall is inserted into the notches of the coupling, which secures the highest safety index. In turn, the radial joint is sealed with 1 or 2 O-rings. There is point sealing in this case, i.e. only at one or more gaskets, depending on the system.

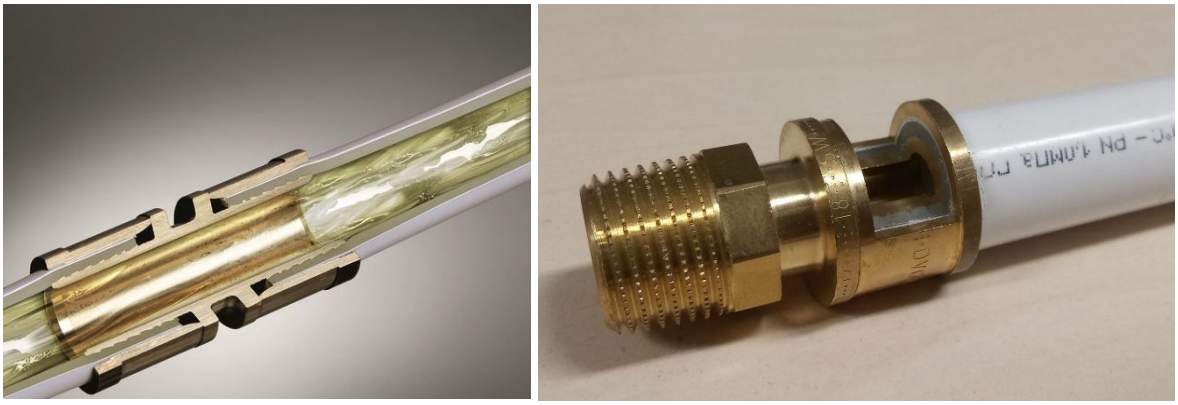


Fig. 3.36. Axial joint – cross-section of a finished joint (Promotional materials of KAN-therm)

Fig. 3.37. Radial joint – view of sealing elements of O-ring type and finished joints (Promotional materials of KAN-therm)

The solutions applied in sanitary and heating installations should be characterised by reliability. A lot depends on them – tightness and lack of failures, resistance to mounting errors and, last but not least, efficient and easy installation.

One of the most popular systems dedicated to sanitary and heating systems, but also compressed air systems, is TECEflex.

It consists of 3 types of pipes:

- multi-layer, for potable water supply systems, heating systems and air supply systems,
- sanitary, made of PE-Xc,
- heating, made of PE-Xc covered with an anti-diffusion layer of EVOH type.

All is complemented by brass, bronze and PPSU couplings as well as blocking bushes and there is only one coupling type dedicated to each of the three pipe types, so risk of mixing up elements during installation is eliminated.

Fig. 3.38. PPSU fittings (Note: fig. 3.38 – 3.57 - Promotional materials of TECE)

Fig. 3.39. Brass couplings – example adapters to external and internal thread

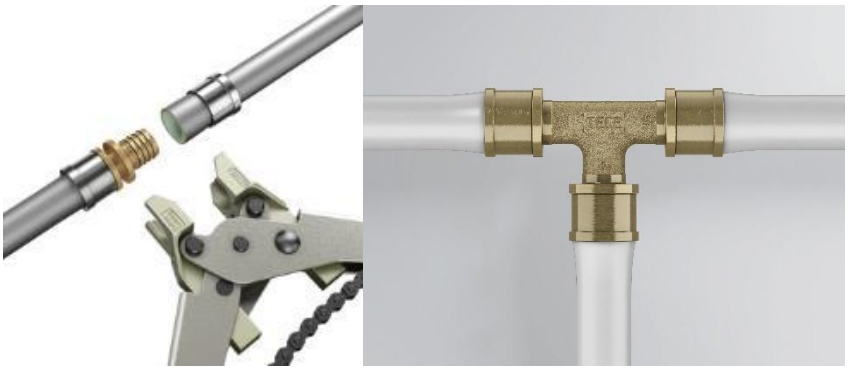


Fig. 3.40. Joint during preparation together with a tool for stabilising rings sliding and a complete, joined T-connector

Pipe joints in the TECEflex system are made with the axial clamping technique – a pipe is swelled and inserted in a coupling and then is moved on the clamp to tighten and stabilise the joint.

Fig. 3.41. Swelling a pipe with a tool dedicated to TECEflex

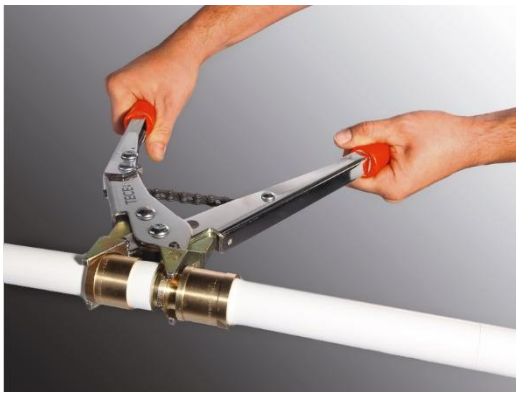


Fig. 3.42. Inserting the bush stabilising the joint

Such a connection technology does not require any O-rings or other additional sealing elements and guarantees safety and tightness of connection. It is also highly tolerant to installation errors.

Unfinished connections are visible with bare eye, so it is easy to determine the place of any leaks during the leak test.

Clamping systems are characterised by minimum pressure losses at couplings, very high pressure and temperature strength as well as light materials and simplicity of installation. Pe-Xc pipes and multi-layer pipes are intended for at least 50 years of use and most producers grants at least 10 years warranty for the tightness of their systems.

Due to small sizes of couplings and flexibility of pipes, special attention needs to be paid to the possibility of simple concealed installation in walls and flooring. The pipes can be easily adapted to the shape of flooring or a groove and the couplings do not need any additional installation space.

Sometimes, however, pipe elasticity is also considered as disadvantage. Similarly to PP pipes, they require small distances between supports if led as suspension systems (compared to, for instance, steel pipes).

Pipes in clamping systems most often occur in diameters of up to ca. 2” (DN50), what does not allow to use them in systems demanding larger diameters or systems in larger complexes, e.g. garages. It would be economically unreasonable due to a high unit cost of materials and couplings with such wide diameters.

Other systems allowing preparation of reliable and safe connections, in hard-accessible places as well, are systems based on radial joints. Most frequently, making pipe joints does not require any expensive tools and the system consists of multi-layer pipes and couplings composed of several elements: the body, screwed or pressed bush or a clamping ring and O-rings, responsible for permanent sealing of the joint. One of the representatives of such joints is the TECElogo System, which is described here due to its additional features, i.e. limitation of the range of required tools to the absolute minimum and the reversibility of made joints – in the case of a fault, an installation error or change in the concept, the already made joint can be dismounted with a simple wrench and remounted with the same elements. Moreover, the system is universal: it can be employed both in cold and hot water supply systems or radiator or surface heating systems. It can be used in vertical and horizontal installations as well as in concealed or surface mountings.
The system consists of:

- multi-layer pipes of PE-Xc/Al/PE (PE-Xc/Al/PE-RT of type II) in diameters ranging from 16 to 63 mm
- multi-layer pipes of PE-RT of type II/Al/Pe-RT of type II in diameters ranging from 16 to 25 mm
- bronze couplings (threaded adapters only) and of PPSU.

Connection method

Connections are made with the insertion method: cut a pipe, calibrate it and chamfer it – insert – and done.

Fig. 3.43. TECElogo system tools.

Connection is made without any clamping tools. The system requires pipe scissors and a pipe calibration tool. The pipe prepared this way is then slid on the connector stub of a TECElogo pipe coupling, which makes the connection complete.

System installation stages are shown on the figures 3.44 – 3.48.

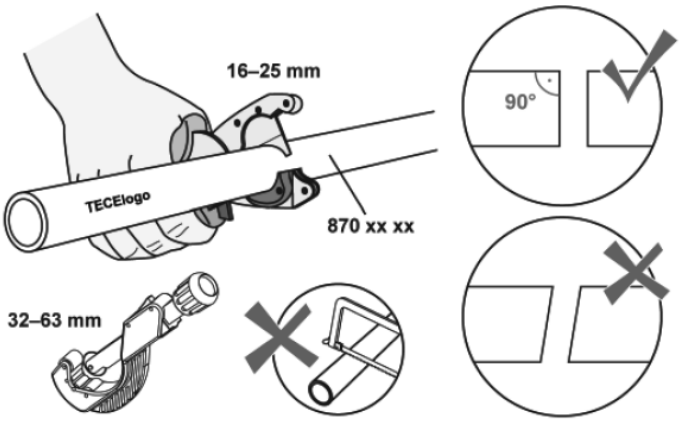


Fig. 3.44. (1) Trim the pipe

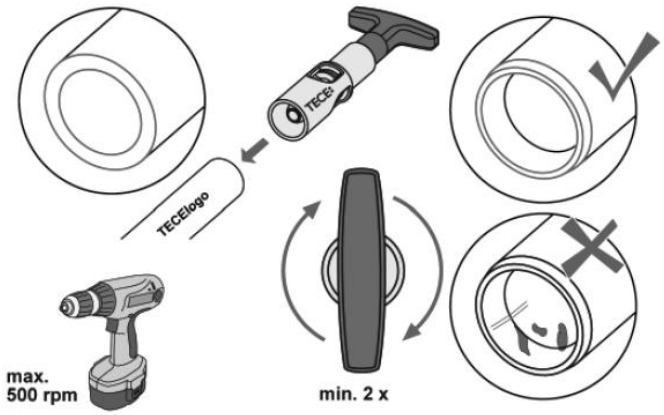


Fig. 3.45. (2) Calibration and chamfering of edges

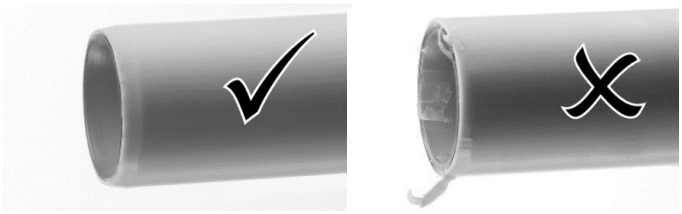


Fig. 3.46. (3) Checking whether the pipe has been chamfered and calibrated properly

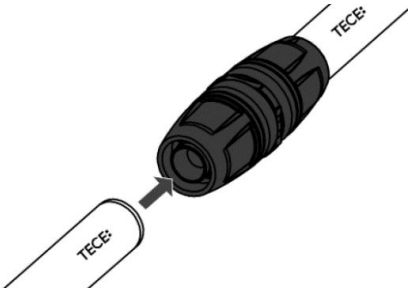


Fig. 3.47. (4) Pipe insertion

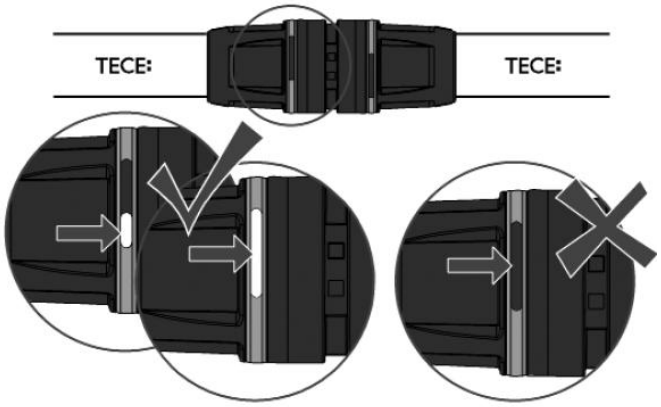


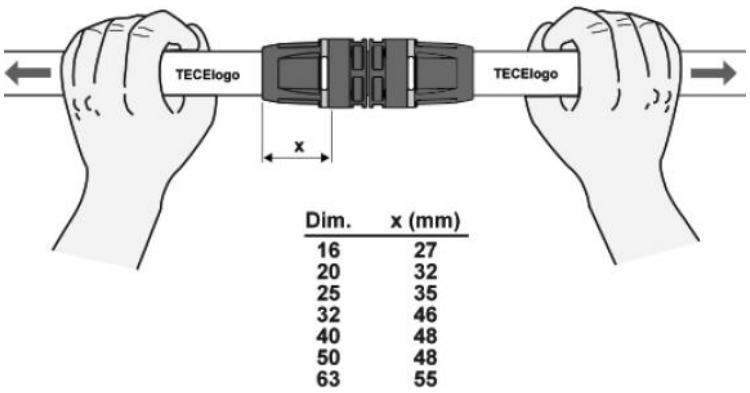
Fig. 3.48. (5) Visual check of joint

The connection is made correctly if the pipe is visible through one of the control window.

In case of installation in a place where a connection cannot be controlled through a control window, mark a pipe before its insertion (with a pencil or a marker pen). Insert the pipe into the coupling down to the marking. The distance from the marking to the end of the pipe depends on the diameter of the pipe (Table 3.6):

Table 3.6: Distance from the marking to the end of the pipe for different diameter of the pipe.

Diameter in mm	Distance from the marking in mm
16	27
20	32
25	35
32	46
40	48
50	48
63	55



Dim.	x (mm)
16	27
20	32
25	35
32	46
40	48
50	48
63	55

Fig. 3.49. Distance from the marking to the end of the pipe / the diameter of the pipe

The complete TECElogo connection must be checked by means of a pull-out test. The pipe cannot be pulled out after insertion.

Disassembly and reconnection

TECElogo connections can be disconnected at any time.

During installation of a new system, all dismounted parts can be reused if the system has not been filled with water and subjected to pressure or temperature. If the connections have been already dismounted after the system has been started, cut the TECElogo couplings of the joint and perform the calibrating and chamfering process again as well as replace the O-rings on the couplings with the new ones.

Note: To dismount and remount the connection, use the TECElogo dismounting tool only.

1. Marking the setting point of the screwed bush

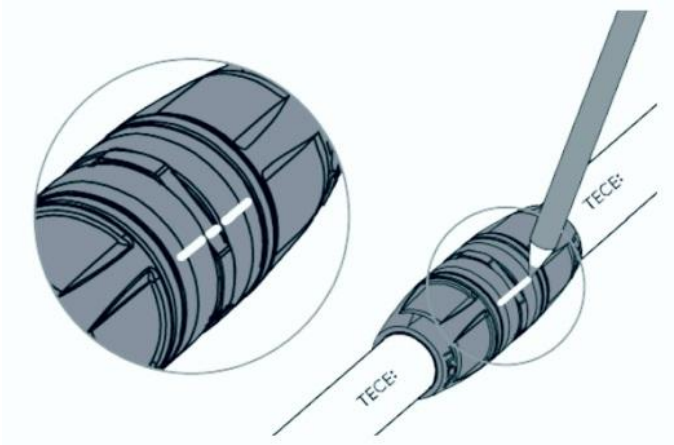


Fig. 3.50. Mark clearly the place of installation of the screwed bush

2. Removing the screwed bush:

Immobilise the coupling and untighten the screwed bushring appropriate wrench.

3. Removing the coupling from the pipe

Fig. 3.51. Wrenches

Move the screwed bush onto the pipe and remove the coupling from the pipe, remove the screwed bush and clamping ring from the pipe. Check the body before the coupling is fitted and, if needed, remove any contamination or residues. If the O-ring is damaged, replace it.

4. Reinstallation of the couplings

A – new installation

Place the clamping ring on the connection stub and tighten the external screwed bush manually. Then, using the disassembly tool, tighten the screwed bush until it audibly "latches" in its end position (see fig. 3.52) and the marking is properly set.

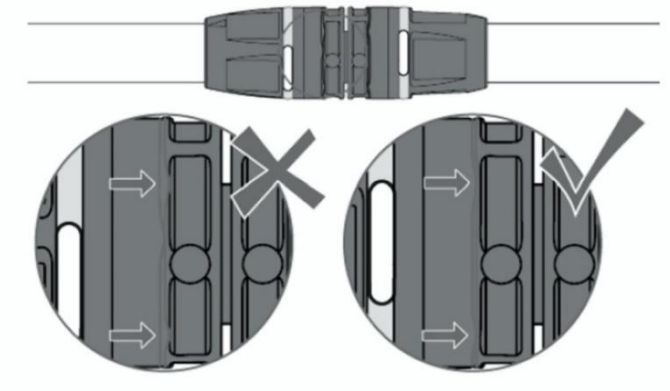


Fig. 3.52. Proper reinstallation

B. Installations after the leak tests and working installations.

In such case, new O-rings should be inserted on the coupling.

Place the clamping ring on the connection stub and tighten the screwed bush. Then, using the disassembly tool, tighten the screwed bush until it audibly "latches" in its end position and the marking is properly set.

Further steps – cutting the pipe to the desired length, calibration and trimming the edges, sliding in and pressing as well as visual check - should be performed according to the description provided above in "**System installation**" section.

The scope of production

Fig. 3.53. System elements and complete TECElogo System installation

The offer of the system manufacturer includes all necessary elements of sanitary and heating installations, such as PPSU, standard brass and bronze couplings, wall elbows, fitting accessories, surface mounted and concealed cabinets, distributors, adapters and system tools as well as multi-layer pipes:

- type PE-Xc/Al/PE (PE-Xc/Al/PE-RT type II) in sizes: 16x2.0; 20x2.25; 25x2.5; 32x3.0; 40x4.0; 50x4.5; 63x6.0 mm – bars with diameters ranging from 16 to 63mm or in coils with diameters ranging from 16 to 32 mm

- type PE-RT type II/Al/PE-RT type II) in sizes: 16x2.0; 20x2.25; 25x2.5 – in a coil

TECElogo couplings

Couplings for sanitary and heating installations are the same and are made of PPSU and a brass threaded connector.

Properties and features of TECElogo couplings:

- the same couplings for sanitary and heating installations,
- Hygienic Certificates,
- high mechanical resistance.

The same coupling can be used for the sanitary, heating and pneumatic installation.

TECElogo connector is very compact and consists only of three installed components plus O-rings:

- Body with an O-ring,
- clamping ring,
- screwed bushring.

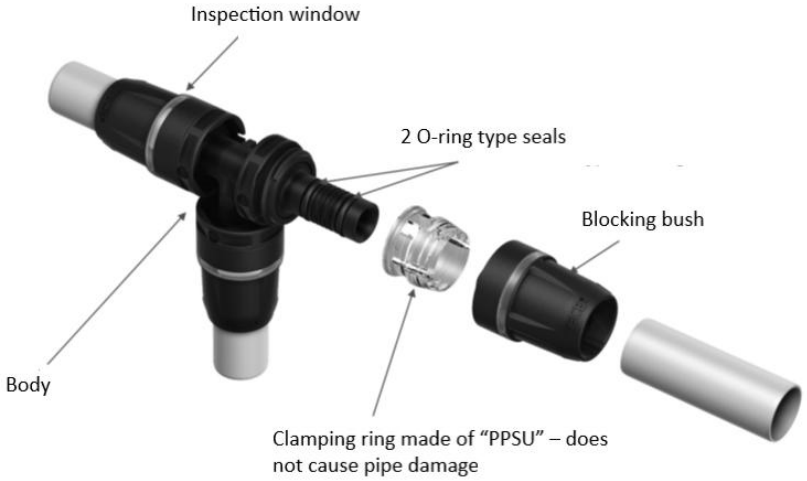


Fig. 3.54. Coupling components

Installation guidelines for the TECElogo system

All pipelines, especially plastic pipelines, elongate when heated and shrink when cooled. These physical properties must be taken into consideration for hot water and heating ducts. Due to the high temperature differences, the ducts must be fitted in such a manner that the thermal elongation is compensated at the elbows or by special compensators. The two solutions of this problem are presented at fig. 3.55 and 3.56.

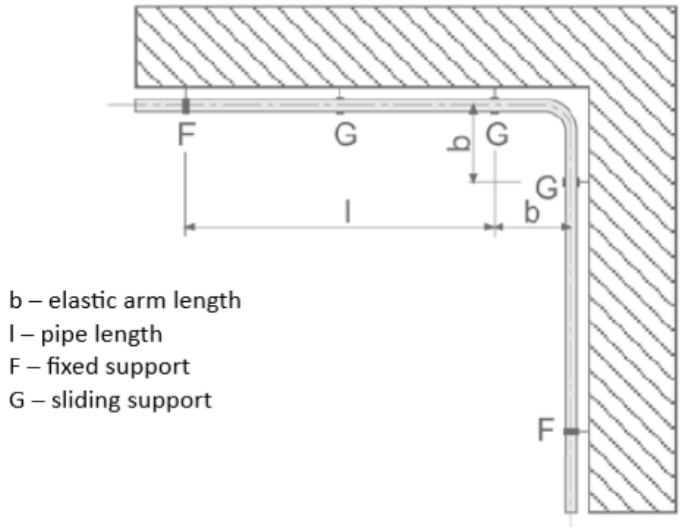


Fig. 3.55. Compensation of thermal elongation by means of change of the installation direction - so-called natural / angular compensation.

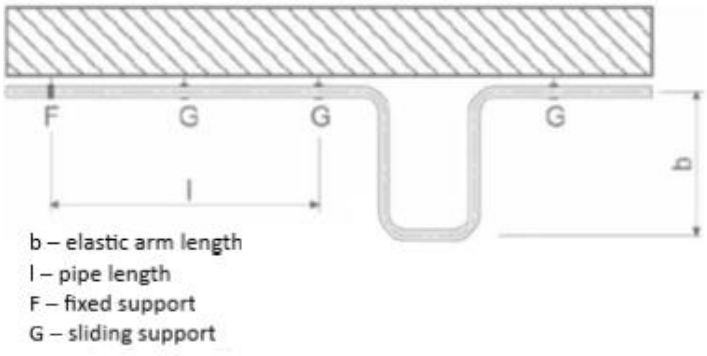


Fig. 3.56. In the case of insufficient space for natural compensation of thermal elongation, U-shaped compensators must be designed, taking into account the length of the elastic arm.

Additional installation guidelines regarding compensation of thermal elongation:

- For installations along floor beading routed on the surface of the wall, only multi-layer TECElogo pipes must be used.
- During connecting radiators from the floor or wall, sufficient space must be provided for thermal elongations.
- All pipelines and connections to radiators in the flooring must be always routed in the so-called "wavy manner".

Methods of installation routing

TECElogo installation ducts must be routed according to the applicable technical rules and standards. The duct routing method cannot have any negative effect on the quality of potable water. To avoid growth of microorganisms, the duct and insulation must be routed in a manner preventing heating of potable water.

In particular, in case of shafts and surface installations, it is necessary to check whether increased insulation of cold water ducts is required in order to maintain proper hygiene. The temperature of potable water cannot exceed 25°C.

Surface mounted TECElogo installations

The fitting method and spacing of grips in case of surface mounted TECElogo installations depends on the conditions at the construction site. The installation must be fitted according to static parameters, taking filled and insulated pipes into account, according to the recognised technical rules (Table 3.7).

Table 3.7: Mounting spacing for surface mounted TECElogo installations by diameter of pipe.

TECElogo Ø in mm	Mounting spacing in m
16	1
20	1.15
25	1.3
32	1.5
40	1.8
50	2.0
63	2.0

Table 3.8: Pipe specific gravity and pipe weight by diameter.

TECElogo Ø in mm	Pipe specific gravity in kg/m	Pipe weight in kg/m
16	0.11	0.21
20	0.15	0.34
25	0.22	0.52
32	0.33	0.86
40	0.55	1.33
50	0.76	2.09
63	1.22	3.26

The pipes must be routed in a manner preventing the sweating phenomenon and transfer of condensate from other previously installed elements. Surface mounted pipes must have thermal insulation.

Flushed TECElogo installations

Depending on the wall structure and quality of the wall, the process of thermal expansion of multi-layer TECElogo pipes in concealed installations may, in extreme cases, result in wall damage. TECE recommends insulation of all multi-layer TECElogo pipes installed as concealed systems. Alternatively, if thermal insulation is not necessary, multi-layer pipes may be installed in protective conduits - this applies to routing in the insulating layer of the flooring (closed at all sides). In principle, TECElogo couplings must be protected against contact with the wall, plaster, cement, screed, quickly binding materials, etc. with a proper cover. Direct contact with the building must be also avoided due to the requirements for sound and thermal insulation.

TECElogo installations in concrete or screed flooring

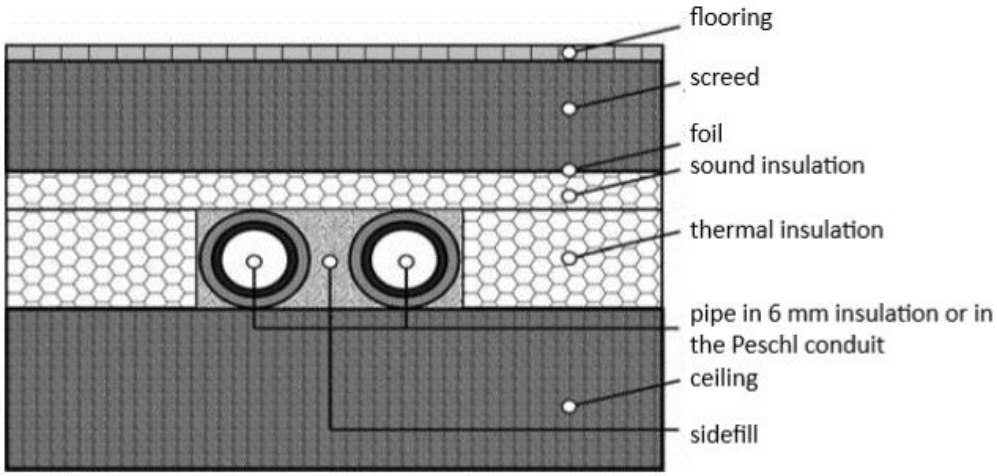


Fig. 3.57. Most commonly applied solution for placing pipes in the flooring.

The pipes must be routed in the flooring according to the following rules:

- The pipes must be covered with thermal insulation or placed in a protective Peschel type conduit, if technical regulations allow it.
- Pipes and fittings must be secured against contact with concrete or other mortars by means of careful installation of insulation, without any breaks or damage.
- Routing the installation through door openings, at least a 10 cm distance must be maintained from the opening edge.
- Pipe penetrations through expansion joints must be made using a protective conduit, ensuring at least 25 cm at each side of the joint.
- Installing pipes in the flooring or as concealed installation, pipes must be routed in the so-called "wavy manner", with 10% pipe margin in relation to a straight line - this ensures proper compensation for thermal elongation of the pipe.
- Pipe elongation must be limited with fixed points to avoid joint damage.
- Pipes must be fitted to the ceiling with grips every 1 m
- Immediately before covering the flooring installation with screed or mortar in a wall grooves, the installation must be leak checked.
- It is important that if the ducts are crossed i.e. at T-junctions the pipes spacing must be 10 x outer diameter.

3.4. Techniques, materials, tools related to sewage installations.

Sanitary and technological sewage system

Historically, the best known material used for construction of sewage systems is cast iron. Due to its durability, this material has many fields of application for installation pipes - from water transport to sewage drainage. To this day, in older buildings many operating fragments as well as entire installations made of this material can be observed. However, it has been almost completely out of the market since plastic pipes appeared.

Cast iron pipes are still used, but only in special cases, such as the requirement of extremely high temperatures resistance, high risk of mechanical stress, specific chemical substance or abrasion by solid particle resistance. In all other cases, plastic have superseded cast iron in common use, mainly due to the weight, simplicity of installation and definitely lower costs of application.

Meeting the design assumptions and expectations of the user, being durable and failure-free, during sewage system installation the rules of installation and technological requirements of manufacturers must be followed regardless of the material used. For this purpose, it is necessary to know how to identify the product and its proper use, i.e. by the knowledge of the OMD (operating and maintenance documentation) of the manufacturer.

Identification of materials is facilitated by the currently applicable law which imposes on the manufacturers the obligation to mark their products in a fixed and detailed manner - if no such marking is provided, the product must be considered as of unknown origin and must not be approved for use in any installation.

Fig. 3.58. Examples of markings stamped on the material or placed as a product label (own source)

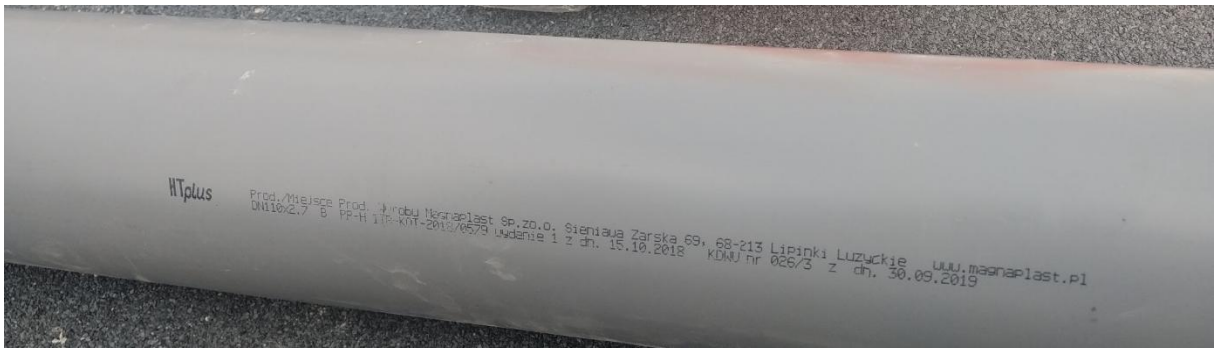


Fig. 3.59. Example of a marking permanently printed on the pipe (own source)

3.4.1. Sewage systems made of PVC and PP.

Sewage system pipes produced on the basis of **polyvinyl chloride (PVC)** have a significant share in the current internal sanitary sewage systems, mostly in detached residential buildings and in construction of main horizontal sewage system pipelines routed in process areas, garages - places with lower noise requirements.

Fig. 3.60. Examples of PVC pipes and fittings (own source)

The advantages of PVC pipes and fittings are as follows:

- full resistance to general and pitting corrosion,
- high smoothness of walls (reducing hydraulic resistances during sewage flow),
- resistance to the harmful effect caused by chemicals,
- very low weight,
- microbiological resistance.
- Thermal resistance reaching (for High Temperature systems - PVC HT ()): for continuous flow - up to 75ºC, for momentary flow - up to 95ºC.

Internal sewage systems made of PVC are produced for the following outer diameters: 32, 40, 50, 75, 110 and sometimes 160 mm. Outer diameter of 160 mm and larger diameters are available usually only for the external sewage systems (orange colour of pipes).

NOTE! In most cases, external sanitary sewage systems are not approved for indoor use (except for technological sewage systems under the flooring).

Fig. 3.61. External PBC sanitary sewage system (own source)

The basic disadvantage of PVC sewage pipes is their low absorption of acoustic pressure (noise) generated by sewage flow. The continuously increasing level of required comfort of use of the installations makes **polyvinyl chloride (PVC) based sewage systems** more and more popular. The basic rules of installation, transport and storage are similar both for PVC and PP sewage systems and will be discussed in more detail further in this book.

HTplus produced by MAGNAPLAST is an example of pipe and fitting systems used for construction of internal sanitary system installations. It is made of polypropylene based plastics and is compatible with most other PP and PVC sewage systems. In addition to the advantages of PVC sewage systems presented above, the use of PP has additional favourable features:

- significantly reduced level of noise generated by the flowing sewage,
- low mechanical impact resistance,
- possibility of installation in the temperatures below 0°C down to -10 ºC (PP pipes are characterised with higher resistance to mechanical impact in temperatures below 0°C than PVC pipes which is a great advantage in case of installation in winter conditions),
- resistance to temperature for a continuous flow sewage at the level of 90˚C (95 ºC for short-term flow).

Magnaplast Htplus is produced with the following outer diameters (in millimetres): 32, 40, 50, 75, 110, 125 and 160.

Fig. 3.62. HTplus system (Note: fig. 3.62 – 3.76 - Promotional materials of Magnaplast)

NOTE! In gravity sanitary sewage systems, it is forbidden to use elbows and T-connectors with an angle equal to or higher than 90º for horizontal sections.

The available angles of elbow profiles and T-connectors in the HTplus system are: 15 **º,** 30 º, 45 º, 67 º, 87 º (for diameters 32 mm-125 mm) and 15 **º,** 30 º, 45 º, 87 º (for diameter 160 mm).

Fig. 3.63. Sewage elbow

Fig. 3.64. Sewage T-connector

PP (and PVC) sewage systems can be connected, for example, with cast iron sewage systems by means of special fittings. An example is presented below.

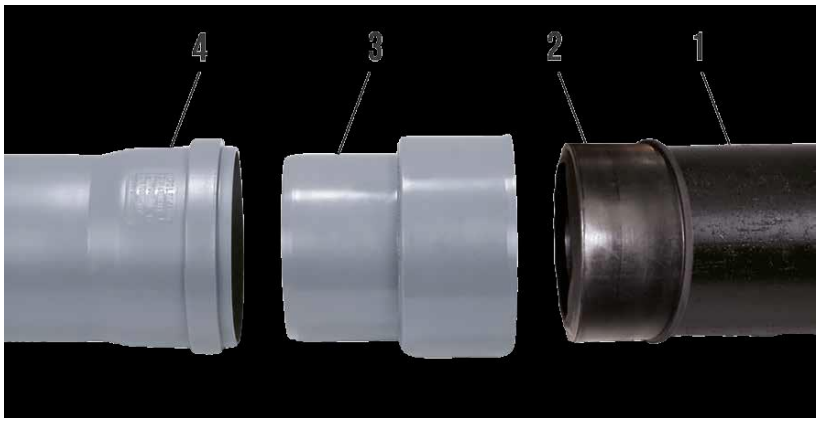


Fig. 3.65. Joining the PP sewage system with the socket-free cast iron sewage system, where: 1 - cast iron sewage pipe, 2 - HTUG seal, 3 – HTUG union piece, 4 – PP sewage pipe

PP (PVC) sewage system installation:

1. Cutting straight sections and creating slants.

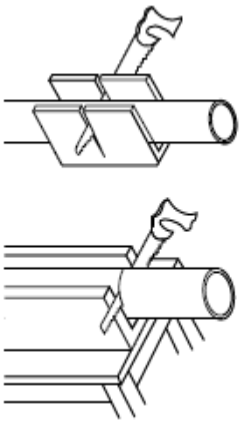


Fig. 3.66. Pipe cutting using a wooden tray

To obtain the proper length, the pipes must be cut with cutters for plastic or, if necessary, fine saws. The cutting plane must be perpendicular to the pipe axis. So-called wooden mitre boxes are very useful for that purpose. The cut edge must be cleaned of any spurs and filed (with a coarse file) at the angle of ca. 15º.

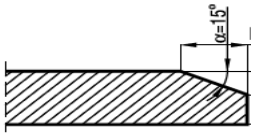


Fig. 3.67. Pipe cut edge processing.

2. Making the joint

The socket joint in the PP or PVC sewage systems is one of the quickest and simplest system among all others. Nevertheless, a specific performance regime and order of the activities specified below is required:

- Before the joining process, clean the connected pipe ends and fittings as well as the sealing elements (seals in the sockets).

Fig. 3.68. Cleaning the plain end of the PP HTplus pipe

- Then, lubricate the pipe end (plain end of the pipe) inserted in the socket with a dedicated slip agent that will reduce the friction during installation (resistance), and carry out preventive maintenance of the socket seal.

Fig. 3.69. Lubricating the plain end of the PP HTplus pipe

- Repeat the control of positioning and sealing elements, by sliding the pipe end into the socket until noticeable resistance and then sliding it out by 1 cm (compensation of thermal elongation).

Fig. 3.70. Inserting in the plain end of the pipe into the socket

3. Fitting

PP and PVC sewage system pipes must be installed in a manner preventing stress, by means of commonly available clamps with the EPDM insert or more specialised clamps characterised with increased vibration insulation (e.g. BISPAT 1000).

Fig. 3.71. PP HTplus pipe fitting using a standard clamp

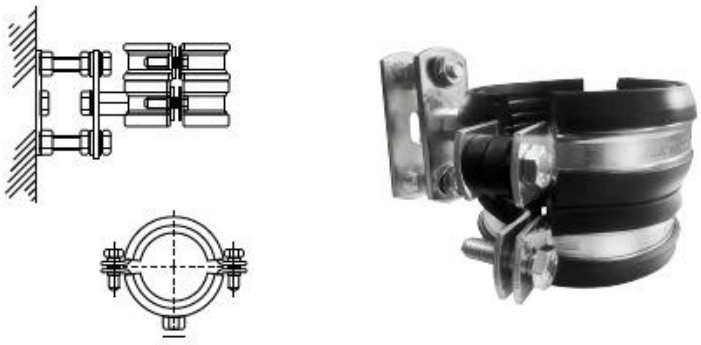


Fig. 3.72. BISMAT 1000 clamp

Installation of the particular sections of the sewage system (PP, PVC) must take into account the possibility of free elongation of ducts under the temperature. Risers are fixed to the wall by placing the clamp right under the socket (it is a fixed point) and at the half-way of the floor height, at a significant distance from the socket (sliding point). The riser must have at least 2 fitting points per floor.

PP and PVC sewage system pipes and fittings intended for indoor installation can be installed directly in concrete or wall. However, it must be remembered to protect the socket joints (particular sealing) from contamination with concrete mortar. Foil or plastic tape can be used for this purpose, by wrapping the pipe carefully at the level of the socket, with at least 20 cm overlaps.

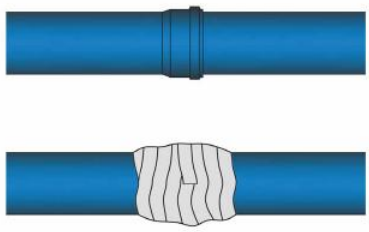


Fig 3.73. Protecting the socket connection from concrete cover

NOTE! During installation of a socket sewage system (PP, PVC), the plain end of the pipe must go into the socket (not vice versa), depending on the sewage flow direction.
An exception is installation of two-socket and slip couplers.

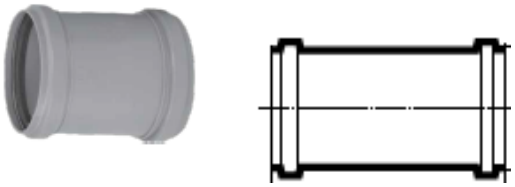


Fig. 3.74. Slip coupler

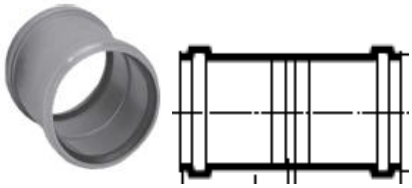


Fig. 3.75. Double socket coupler

NOTE! Changes of directions of routing the horizontal and vertical sections must be reduced to the necessary minimum, using elbows with a wide radius and, thus, preventing significant reduction of the sewage flow rate.

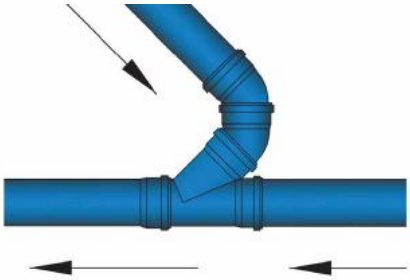


Fig. 3.76. Joining drainages, taking the flow direction into account

3.4.2. Sewer systems made of cast iron.

As has already been mentioned in this book, cast iron pipes and fittings are used only in specific cases (more strict fire safety requirements, particularly high risk of mechanical stress or non-standard features of the transported sewage, such as high temperature or contamination with high hardness solids). Despite multiple advantages offered by the cast iron sewage systems. i.e.:

- high acoustic absorption,
- resistance to temperature changes,
- high durability (including resistance to abrasion),
- stability and invariability of shapes (including increased impact resistance)
- relatively quick fitting of joints,
- possible installation in temperatures below 0°C.

The high price of the particular elements (pipes and fittings) as well as logistic and installation issues related to the weight of the material (cast iron) result in the low % share of these systems in the modern installations of internal sewage systems.

Currently, socket-free pipes connected by means of screwed clamps are used for construction of internal sewage systems. The most popular system is **SML**, intended mainly for household sewage and storm water drainage. In the case of highly aggressive sewage (e.g. from catering outlets, public baths, hospitals, process rooms, oil drainage), cast iron **KML** systems are used. The difference between the systems refers to the outer and inner layers (lacquer, resin, zinc-coating) securing the surfaces of cast iron pipes and fittings.

FITTING OF CAST IRON SOCKET-FREE SEWAGE SYSTEMS (ON THE EXAMPLE OF THE SML SYSTEM PRODUCED BY KZO WITH USE OF CV CLAMPS).

1. Installing the rubber bush.

Fig. 3.77. Installation of the rubber bush on the SML pipe produced by KZO (Note: fig. 3.77 – 3.79 - Promotional materials of KZO)

Remove the rubber bush from the system clamp and place it on the plain end of the pipe. Then, roll downwards the half of the bushing sticking out of the upper edge of the pipe.

2. Coupling the pipes or fittings.

Fig. 3.78. Coupling the SML pipes or fittings produced by KZO.

Coupling the elements means unfolding the seal bush upwards to cover both plain ends (slid one onto another).

3. Placing and tightening of the steel clamp.

Fig. 3.79. Placement of the SV steel clamp (SML prod. by KSO).

4. The last stage is placement of the steel mantle of the CV clamp and tightening the mounting screw with a wrench (hex/Allen key). Alternate tightening of screws must be applied.

Fig. 3.80. A part of an installation made of SML pipes, using CV type clamps. (own source)

The parts of the installation for which intensified pipeline load (riser height, changes of sewage system directions, etc.) with forces that could result in detachment of the system is expected, the joints are reinforced with the so-called "clamping claws". Their characteristic structure, with smooth inner surfaces of the clamps replaces with steel "claws", the joints of the particular elements are much more durable than in cases where only CV is used.

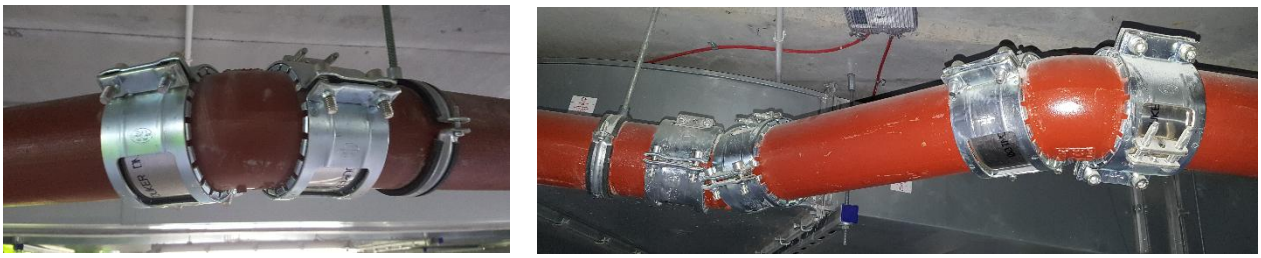


Fig. 3.81. Parts of an installation made of SML pipes, using CV type clamps, reinforced with clamping claws. (own source)

3.4.3. Sewage systems made of HDPE (PE-HD).

HDPE [PE-HD] – sewage systems with increased chemical and mechanical requirements

HDPE (high density polyethylene) – it is a light material (lighter than water), belonging to the group of elastic thermoplastic materials. It can be processed and joined by means of welding or mechanical connectors (including traditional socket connections). HDPE is resistant to water, salt, acid, lye, alcohol and petrol influence.
Due to the abovementioned features, it may be used in almost all areas of construction engineering, taking into account technological processes (except for certain application in the chemical industry). It works well in residential construction, industry, laboratories or workshops, both for drainage of clean storm water from roofs, dirty water from car parks, municipal and process wastewater. In case of high grease content and clogging, HDPE sewage systems can be cleaned hydromechanically, using hot water injected under high pressure, without loss of its properties and tightness.
Due to HDPE elasticity, sewage systems made of this material are characterised by high resistance to mechanical damage as well as great absorption of noise generated by the sewage flowing in the pipes. Nevertheless, to obtain this effect, it is necessary to observe the guidelines of the manufacturers in the scope of processing and fitting of installation materials that form the components of the system.

Delivery and storage of materials
HDPE pipes and fittings are resistant to weather conditions (including UV radiation) and have high impact resistance, even in temperatures below 0°C. They can be stored outdoor or indoor, without special environmental requirements. This material is light and, thus, it can be handled or transported mechanically in larger bundles and baskets, without regarding cracking or ageing of the material.

Joints and installation of elements
Geberit PE system pipes and fittings can be joined by means of butt welding, electrofusion, or by means of socket, screw and flange connections. Due to the thermal expansion coefficient characteristic for all these materials, installation of HDPE pipelines requires natural or systemic longitudinal compensations, based on compensation sockets, according to the manufacturer's instructions.

The system elements are installed on standard and generally available grips and hangers or on system elements, if is required by the manufacturer's installation technology. In specific circumstances, use of specialised grips or supports ensuring improved rigidity, protection against noise or non-flammability may be required if the installation runs through the fire separation partitions.

Fig. 3.82. Pipe cutters for diameters up to 160 mm and from 200 mm
(Note: fig. 3.82 – 3.83; 3.86 – 3.92 and 3.94 – 3.98 - Promotional materials of Geberit)

Fig. 3.83. Welder for electrofusion couplings as well as a Geberit electro- and thermal couplings

Using the Geberit welder allows to connect up to 3 couplers in a single welding cycle, thus reducing the installation time.

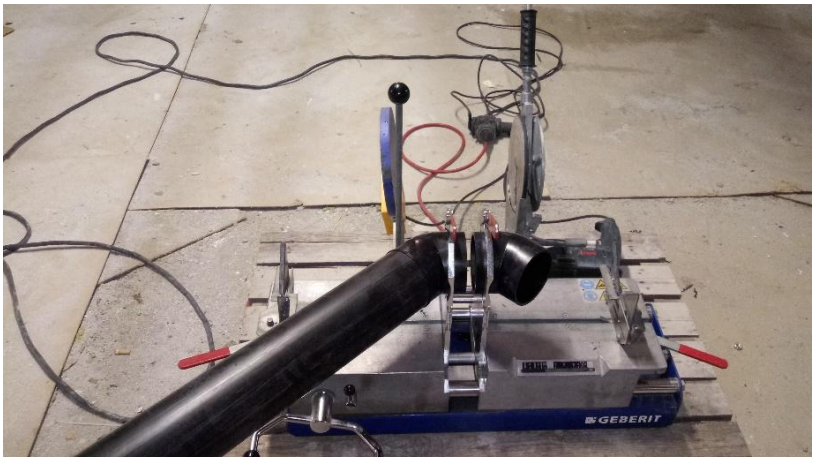


Fig. 3.84. Welding machine for butt welding, equipped with a mechanical plane and heating plate.
(own source)

In the assembly jaws a part of the installation and the fitting is placed, ready for welding.
Preparation of the elements for installation, material processing.

The materials (pipes, fittings, grips) are ready-for-use elements, but their joining, especially by means of welding, requires proper preparation in PE pipe systems. Cutting the pipes to the desired sizes is also unavoidable and is connected with the necessity to prepare correctly the cutting edges, by removing material chips and spurs, smoothening the edges or slanting the plain edge of the pipe that is going to be inserted into the socket. In case of a socket connection, check the required depth of inserting the pipe into the socket in the manufacturer's instructions and mark it on the plain end of the pipe that is going to be inserted in. After the pipe is lubricated with a slip agent (it must not be fat!), slide the pipe in, exactly up to the previously made marking.

In case of welded joints, after mechanical processing of the material and verification of its fitting to the installation site (using previously prepared grips), the elements must be cleaned, scraped and degreased. Welding must be performed in strict compliance with procedures and heating times for the adopted method.

The fig. 3.85 presents the correct order of activities in butt welding.

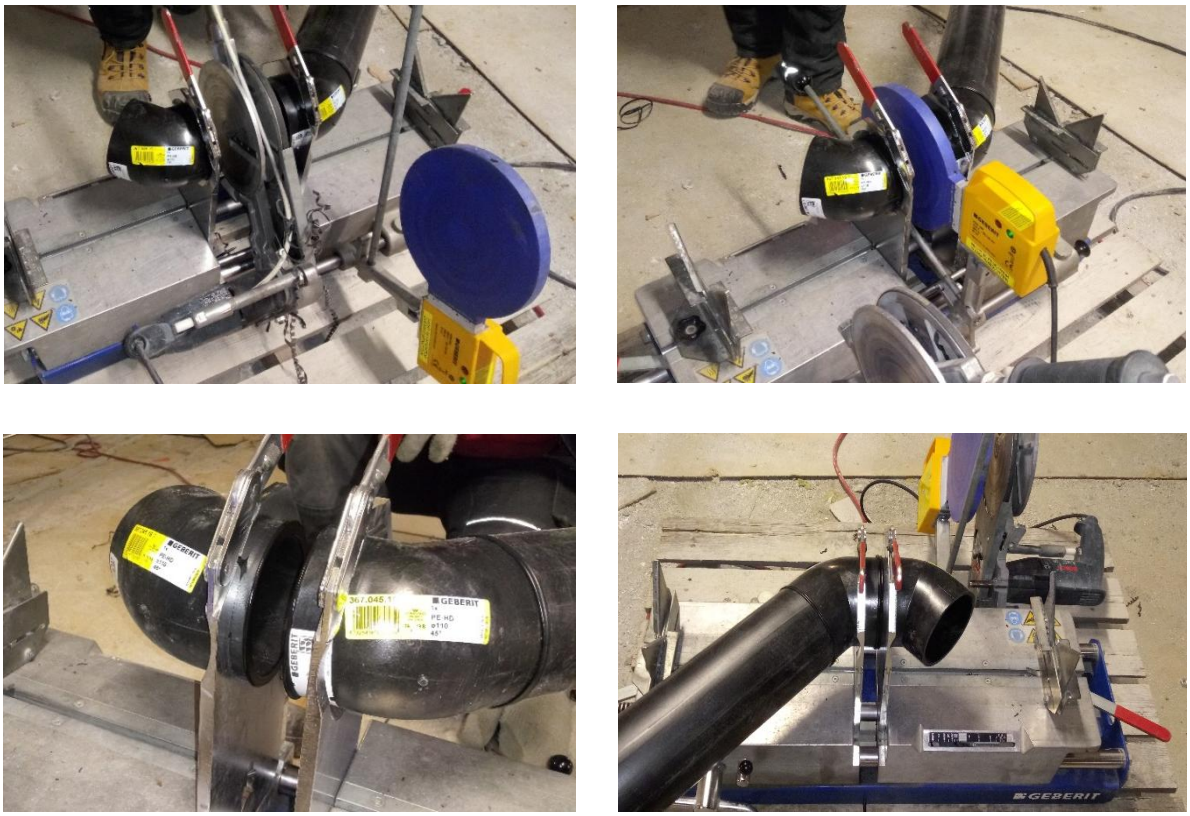


Fig. 3.85. (top left) contact surface trimming; (top right) material heating; (bottom left) pressing together the welded elements; (bottom right) cooling phase. (own source)

Installation of the system

Installation of vertical and horizontal sections of the sewage system is performed on a combination of sliding and fixed grips - the so-called fixed points. Only proper construction of the grips guarantees that the installation will remain in place and will not move uncontrollably or leak.
The maximum distance between the consecutive fixed points in the Geberit Pe HDPE pipe system is 6m. In the case of sanitary sewage raisers, fixed points must be located at every floor (spacing not exceeding 6 m). If the installation is routed in the ground, the fixed point can be a concrete block or any other fixed underground element.
In case of installations covered with concrete in foundation slabs, no fixed points or compensation sockets are used. At the penetrations of installations through building partitions, the fixed point can be the partition itself if the pipe is fixed to it.
Using protective insulation is necessary at locations where the installation runs through walls and ground or expansion joints - this will prevent failures of the installation caused by the pipes being cut by moving structural elements during the building settlement.

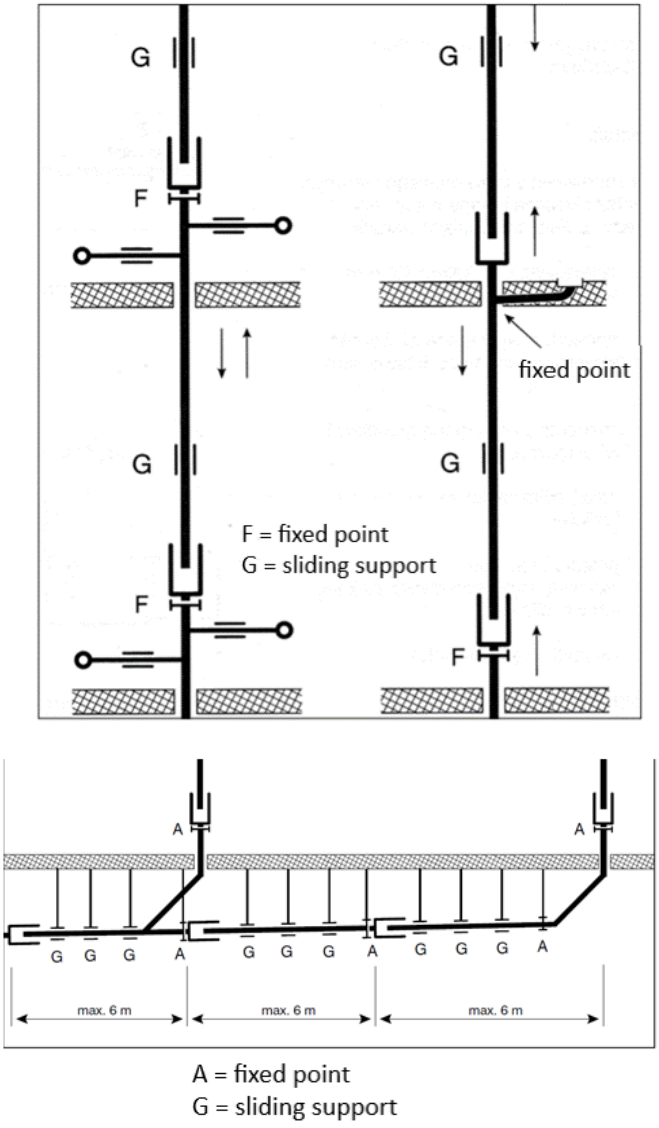


Fig. 3.86. Riser and horizontal pipe installation diagrams for the Geberit Pe system

If the pipeline cannot be installed on hangers with required spacing or if the temperature or temperature of the medium in the pipeline will exceed 50 degrees, the installation can be installed using a special support gutter, according to the guidelines of the system manufacturer.

Fig. 3.87. A part of a complete installation mounted by means of grips, performed in the PE system produced by Geberit

Fig. 3.88 Among many accessories, such as drains, cleanouts, horizontal branches and system fittings, Geberit offers also a unique monolithic fitting system for connection of sewage system levels from the sanitary facilities, called Geberit Sovent. This element ensures high time savings in installation of raisers and increases the admissible capacity of raisers in relation to the solution based on traditional couplers with the same diameter

Combinations with other materials

Due to the normalised outer diameter of the pipes (identical to PVC/PP pipes) and developed system components, the HDPE sewage system can be connected with almost all traditional and modern sewage systems.

Fig. 3.89. Geberit PE/cast iron system adapter

Fig. 3.90. Geberit PE/stoneware system adapter

Fig. 3.91. Clamp of the Geberit PE system

Fig. 3.92. Geberit PE system adapter with a heat shrinking coupler allows to connect the system to any non-standard sewage system

Repair of HDPE pipe damage

In construction conditions as well as at a later stage of operation, the finished installation may be damaged as a result of performed works. The most common forms of damage are cracking as a result of very strong impact of elements and building materials as well as punctures, cuts and holes made

by sharp tools. The damaged fragments of the pipes must be replaced using new pipe sections and electro-couplers. In case of any minor damage and no possibility to replace the broken fragment of the installation, a repair kit for can be used.

Fig. 3.93. Repair kit with accessories (own source)

Storm water system

HDPE pipelines, as in the above described Generit PE system, can be used successfully for internal gravity drainage of roofs and terraces. Due to lower variability of temperature of the transported liquid (only wastewater), a smaller spacing of the compensation couplers and fixed points is required for the raisers - it is 6 m for this application. For other cases, all guidelines of the manufacturer must be observed.

Roof and terrace vacuum drainage

Due to its elasticity, resistance to mechanical stress, durability and tightness of joints, use of HDPE pipes in vacuum drainage installations is a true innovation in the storm water systems.
Many manufacturers have developed and distribute similar systems. Under the commercial name Pluvia, Geberit offers a system of drainages, pipes, fittings, hangers and all types of accessories and tools necessary for proper construction of a complete, operable and durable installation.
The working principle of the vacuum drainage is resigning from the traditional layout of gravity drainage where, according to the standard, in addition to the water drained from the roof, there must be at an least 30% margin for the air stabilising the water flow in the pipeline. The basis of functioning of the vacuum sewage system is assuming 100% filling of the pipelines and generating a vacuum force sucking the water by the drainages and draining it to the tank at a high speed. Meeting these assumptions allows to significantly reduce the diameters of pipelines and the scope of the installation (less number of risers) as well as allows to route the installation without the slope required for the gravity sewage system.

Effectiveness of operation of the vacuum installation can be guaranteed only by proper selection of drainages and pipelines, with accurately determined lengths. If the designer does not approve it, it is inadmissible to move, change, shorten and/or elongate designed installations or its parts - this may result in deterioration of the operating parameters and, sometimes, even in complete malfunction of the installation.

Due to differences in the structure of the particular systems, it is also inadmissible to construct an installation designed in a specific system with use of even very similar elements of other manufacturers or mixing different materials in a single installation. In case of any change, the design must be verified and confirmed by the designer.

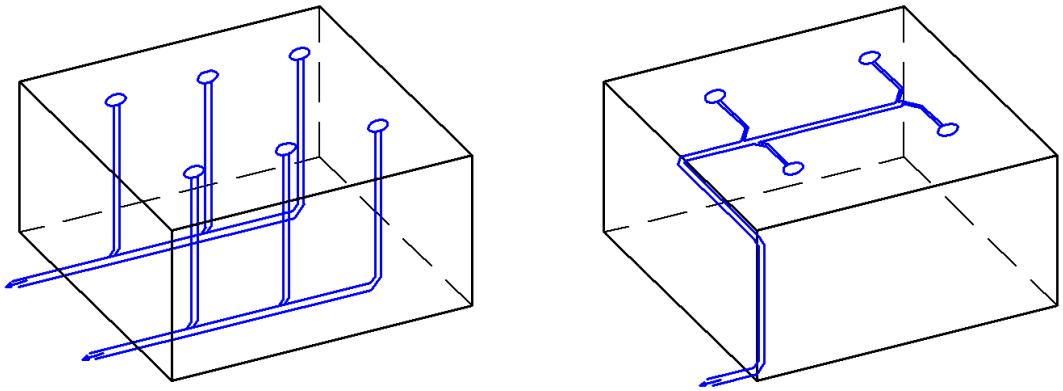


Fig. 3.94. Comparison of traditional gravity drainage and pressure drainage

The complete Pluvia vacuum drainage system offered by Geberit consists of such elements as drainages with 3 diameters (d56, d75 and d90 mm) adjusted to various roof structures and coverings, pipes with diameters from d40 to d315mm and a rich variety of fittings, a system of hangers that guarantee full and durable fitting of the installation as well as tools and accessories for construction and installation of the system.
The vacuum system can be used for drainage of all types of flat roofs, terraces, roof garages and even to collect water from traditional roofs with significant slopes, by placing the drainage in a gutter with a proper structure.

Accessories for installations and drainages

Pluvia installations can be fitted traditionally, with installation clamps, directly to the building structure. However, due to high forces acting on the grip as well as noise generated by the flowing water, it is recommended to install horizontal sections on a system of dedicated hangers with an indirect fitting profile with a square cross-section and system grips. Use of this system facilitates and accelerates the fitting process, ensures ideal levelling of the installation (after the support profile is levelled, the grips keep the drainage pipeline horizontal) and reduces the number of fitting points of the installation to the building structure.

Fig. 3.95. Fitting the Pluvia installation on traditional grips attached to the building structure

Fig. 3.96. Installation of Pluvia horizontal pipes on system hangers. 2 solutions of fixed points may be observed: by means of 2 grips installed at the electrofusion couplers and by means of a grip and clamp dedicated to fixed points at the change of vertical and horizontal direction of the installation

Identically to GEBERIT PE systems, joining and fitting of risers and horizontal pipes of the pressure Geberit Pluvia installation can be performed by means of butt welding as well as using electro- and thermal couplings. As 100% tightness of the installation is required, no other types of connections are used. Compensation sockets are applied only for the raisers, at their base and then at every 6 m along the length of the raiser.

Tools, accessories, procedure and regimes used for welding joints are identical to those used for the joints discussed in the section regarding gravity installations made of HDPE pipes.

Due to narrower diameters and the necessity to make all connections as welded ones, it is recommended to prefabricate large sections of the system on the floor or in workshop and then to mount them– due to a low weight of the material, its flexibility and the structure of the system handles, it will not pose any difficulties and it will guarantee high quality of connections.

If it is not possible to construct emergency gutter or attic overflows, the emergency vacuum sewage system can also be considered as emergency drainage. For this purpose, a doubled parallel drainage installation is constructed with traditional drainages, but equipped with special water level increasing elements. In case of an overflow or clogging of the basic installation, the water level on the roof rises and overflows to the drainage with a higher structure.

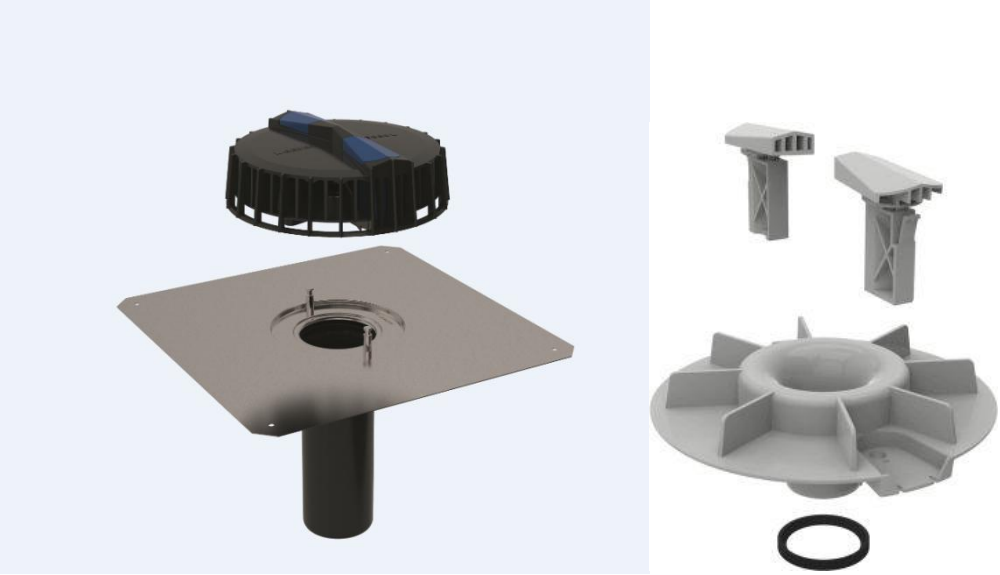


Fig. 3.97. Geberit Pluvia system drainage (one of many available solutions, depending on the roof structure and coverage type) and the level raising element fitted to the standard Geberit drainage

Due to a relatively narrow diameter of drainages, it is crucial to protect them against clogging during construction and against freezing and contamination during operation. For this purpose, the drainages supplied to the construction site are equipped with special temporary protective plates, which should be dismounted after the completion of the roof works with simultaneous equipment of the drainage with the target instruments and a protective basket.

Under climatic conditions of the Central and Northern Europe, all applications of the vacuum installation inlets must be equipped with heating cables or rings before mounting and connected to a properly designed electric system.

Fig. 3.98. Ring and heating wire

After the installation or its part is completed, carry out the leak test, plugging the installation at its base and filling it with water up to the level of roof drainages. The installation is considered tight if there is no water level drop at the drainages and no leakage is observed on the surface. After a successful leak test, the installation or its sections requiring anti-dewing protection are covered with rubber mat or coating insulation.

4. Work organization

Due to an increasingly higher number of systems in contemporary buildings and the market requirements for the duration of implementation and the conservation of space to be taken by a system, it is vitally important to coordinate works among different disciplines already at the designing stage and well preparation and organisation of works at the construction site. In this light, it is immensely important to read designs properly, prepare valuations, supply resources to the construction site and the routing and execution of systems in an already constructed facility. Any errors in any of the above elements will lead to delays in delivery, corrections or alterations and, in turn, considerable financial losses.
Proper planning and order of conduction of works at the stage of execution depend first and foremost on precision of the bill of quantities, the knowledge of the employed technology and understanding of the executive design.
A complete design study must always include a plan of rooms and the profile or extension of systems covering the ordinates for system routing. In addition, depending on the complexity of the given facility, in the design study the designer can add further drawings such as details of hydraulic hubs, structural details of load-bearing beams, solutions for hard points, solutions for collisions etc. If the available documentation is not sufficiently legible and unambiguous in this respect, the contractor should request the construction work manager/construction site manager to provide the complete design solution.

4.1. Elements of pricing

The basic part of the financial documentation accompanying the construction processes are construction cost estimates. These documents define the prices for execution of individual scopes of works and they all add up to the overall financial value of the entire investment.
Construction cost estimates are prepared at each stage of a construction investment, starting with the estimation of overall costs necessary for the performance of the entire undertaking (e.g. the investor's cost estimate) and ending with the as-built cost estimate confirming the level of costs sustained for individual executed scopes.
Construction cost estimates (valuations) are made on the basis of the following quantitative data:

- **bill of quantities** – specifications determining the type and quantity of individual elements of the given scope of works, made before the commencement of works,
- **take-off** – specifications determining the type and quantity of individual elements of the given scope of works, made after the completion of works.

The basic element of pricing which the sanitary system fitter may have to deal with is the bill of quantities compiled on the basis of the design and/or site visit in the facility.
In the first case, it should be enough to read out the design data and juxtapose them with the data from the producer of the material/system in terms of standard consumption of materials, the necessary tools or slings used per running metre of system.

The other case entails changes of all sorts introduced already after the construction phase at the investor's or the supervision inspector's request. Such changes are most frequently related to the necessity to resolve some collision, but it is quite often the case that they are made on use-related grounds and sometimes even merely for aesthetic reasons. In such a case the contractor must not only have knowledge of the design, but also be aware of the changes being introduced, have the knowledge of the technology, its potential and its limitations and the consequences of introducing such changes (regardless of the designer's entry in the design or construction logbook sanctioning them).
Proper quantification of the needed materials, estimation of time required for completion of works, accounting for the necessary auxiliary works (e.g. time for discharge of water from a system, additional pressure test etc.), are the basis for reliable valuation of works and their planning.

4.2. Elements of scheduling

The construction, along with each and every of its stages, is a very complicated undertaking. It requires immense property and financial outlays and, in turn, proper planning in time.

The above planning in time of individual construction stages is referred to as **the schedule of construction works.**

Schedules of construction works very often form integral parts of contracts concluded between companies participating in construction processes, such as the bank, the Investor or the smallest contracting companies. It is, therefore, important for such planning to be carried out on the basis of in-depth analysis and viable assumptions.

A schedule of construction works (including installation works) is based on the following:

1) Determination of the purpose of implementation (the scope of works);
2) Determination of tasks necessary to achieve the aim (works comprising the scope of works);
3) Determination of the order and time necessary to perform the determined tasks.

The schedule of individual scopes of works is a part of a collective schedule of all construction works conducted in all disciplines. Therefore, it is immensely important for the accepted time assumptions to correspond with the other works being part of other disciplines so that the planned works do not exclude (block) other works that have also been planned for the same period of time.

No.	DESCRIPTION OF WORKS	Commen-cement	Completion
24	Storm water system level -1	2017-12-20	2017-01-18
25	Storm water system level +1	2017-01-13	2017-01-23
26	Hydrant installation	2017-02-03	2017-02-28
27	Hydrant cabinet installation	2017-02-27	2017-03-03
28	Storm water tank installation	2017-01-30	2017-02-05
29	Separator installation	2017-02-18	29.02.2017
30	Pressure tank unit - supply	2017-02-22	2017-02-25
31	Installation of the pressure tank unit and water station	2017-02-25	2017-03-15
32	Water station insulation	2017-03-06	2017-03-15
33	START-UPS	2017-03-20	2017-03-23
34	ADJUSTMENTS	2017-03-20	2017-03-23
35	Final operating and matching tests of the installation	2017-03-27	2017-03-31
36	Supply of as-built documentation (version for acceptance by state services)		2017-03-31
37	Supply of as-built documentation (version for the Investor)		2017-04-15

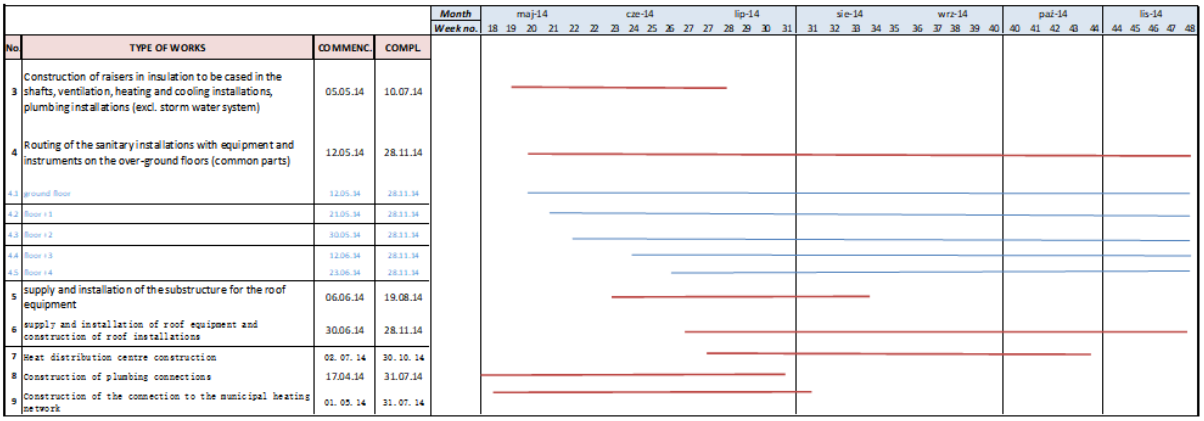


Fig. 4.1. Example fragments of schedules of construction works. (own source)

In the case of the fitter of a sanitary system, the issue of planning and organisation of working time comes down to acting within individual timeframes set for the given scope of works and planning of individual works included in such a scope. To do this, the skill of routing of the executed fragments of a system in the facility, which will allow the fitter to plan their consecutive activities better.

System routing entails measurements from fixed structural elements of the building and determination of lines/routes through which systems will run. To verify whether the scale of a drawing is correct, each and every time before proceeding to work, it must be checked whether the distances provided in the drawings (e.g. between walls) correspond to the actual distances at the construction site. After a line or a point is measured from a structural element, the route must be marked permanently in the manner consulted with the construction work manager – e.g. traditionally with a chalk line and a routing chalk. Another, more and more popular, solution is the routing based on fixed points determining designing axes and cross-line lasers which connect those points for the duration of sling mounting only. Currently, it is quite often the case that ceilings and walls are already made before the fitter of the system starts to work and such a clean routing method is generally the only one to be used in such a situation. Only after the route or its larger fragment is determined, it will be evident whether it runs according to the design, works well with

other disciplines, does not collide with cable routes and other sanitary systems and whether it fits to the already executed openings in the structures of ceilings and walls.

After routing and confirmation of placement of a system, handles and supports can be mounted, taking into account their technical parameters and spacing as specified in the design and the technical documentation.

Due to the precision of execution of reinforced concrete works usually being +- 2 cm, when routing system courses, one cannot refer only to the fixed length of slings measured e.g. from the ceiling. Each and every time before a system is installed on slings, their linearity and slopes must be checked so that the installed system does not have to be dismounted and adjusted.

5. Ethics of work

Codes of professional ethics for some professions, those with special social meaning and a deep impact on human situations, have been compiled for a very long time.

At present, however, much attention is paid to values virtually in any profession. The industrial era ended – not only physically, but also spiritually. The binder related to that era, industrial relations, is fading away as well. At the time of virtual network-based organisations spread across many locations, a new binder is needed – values.

The management manner, organisational culture and organisational ethics cannot be enacted overnight and one cannot count that the actual state will adapt to one's needs. This is an lengthy process the performance of which requires a good concept, proper communication, consistency, patience, trainings and monitoring. Sometimes personal changes must be reverted to. It is highly significant who is employed, who is allowed to work in an organisation – whether or not there will be good cooperation with such a person, also in terms of building or maintaining the desired organisational culture and ethics. However, such diagnosis is not easy to make. It requires knowledge, experience and intuition. It is easy to make mistakes here, for instance employ only people similar to each other in terms of age, education and culture. Such homogeneous teams may fail where new solutions and are sought and extraordinary situations have to be dealt with. Heterogeneous teams do a much better job, which are teams composed of people of different sexes, at different age, with different experience and education, representing diverse disciplines of knowledge and speciality, more creative in general. In a lot of companies, this is what **diversity policy** is: it is said how valuable "diversity" in teams is.

Helpful in shaping the principles of ethics in organisations are codes of good practices, more often than not referred to as **codes of ethics** – they promote selected values and fair and ethical practices (of conduct and behaviour), both inside the organisation and in its relations with the external environment, notably with all stakeholders.

Therefore, the function of such codes is twofold: internal and external. The internal function is expressed in striving to promote ethical practices and eradicate unethical practices in one organisation. The external function is expressed in striving to find the relations with external partners on the followed ethical standards and values. This activity may lead to benefit for the given organisation as well as a result of feedback. The external function also entails the shaping of good image of the organisation.

For several dozen years, the number of corporations and larger companies employing codes of good practices has been growing in highly developed countries. It is assumed that most global companies already belong to this group. According to various estimates, such codes occur in 18-23% of medium and large organisation operating in Poland.

5.1. Status of the construction worker

Construction enterprises have a specific nature. In most companies, there is a division into two closely cooperating employee groups – supervision employees (engineers with a university diploma, foremen, construction work managers, construction site managers, contract/design managers), who direct the execution of a building structure in a specific place or to a specific extent, and manual labour workers – persons having the skills and qualifications to carry out physical technical activities at the construction site.

The construction industry is witnessing many problems related to the deficit of manual labour workers in particular. No labour is one of the more burdensome barriers in the operation and development of construction companies. There is no supply of new workers in the country, there is no education that would be effective for the labour market and that would supply young and qualified craftsmen and specialists in such professions as the following: Steel fixer, concrete placer, shuttering carpenter, bricklayer, tile layer or hydraulic. The experienced part of the workers have retired and they did not even have the opportunity to teach their hands-on knowledge. This results in more and more companies starting to employ workers from abroad. This resulted in multiculturalism among construction works crews and a stronger need for acceptance and respect for the norms and customs of others.

In each organisation, the personal freedom is to some extent limited due to the requirement to follow the working strategy and discipline, achieve collective aims, perform tasks and follow instructions of superiors etc. From the vantage point of ethics, there should be no more limitations than what is absolutely necessary. Furthermore, people should understand the reasons for which some limitations are necessary so that they accept them. In the case of construction industry organisations, this mostly applies to OHS regulations and observance of the requirements of technology and the ordering party, other important work-related procedures, specified limitations and self-limitations related to teamwork etc. There should be no limitations where they are not absolutely necessary.

5.1.1. Ethical standards in the recruitment phase

An organisation builds its image through quality of communication with prospective workers. Ethics provides that the information given to candidates both in the recruitment phase and after it, when communicating a refusal to hire, should be true. A high standard in this area includes reliable and specific job descriptions and specification of offered worker benefits, including the spread of possible earnings. Benefits for the worker should be described specifically, e.g. “We allow you to obtain a crane operator’s licence in 2 years.”

A high recruitment standard also involves a situation where all job applicants have an opportunity to demonstrate their skills regardless of sex, ethnic origin, disabilities, age and other factors unrelated to the job. All forms of recruitment should be related to the tasks that will be performed on the job. It is recommended to use the so-called job samples as a stage in the recruitment process for construction industry jobs involving manual work. For supervision-related jobs, one can test their knowledge or skills in using given software.

Questions which go beyond the code of labour and penetrate the personal life of future employees are not a good choice. Such issues as the worldview or addictions should not be used as actual criteria to assess a candidate.

5.1.2. Quality of life at work - friendly work environment

Upon signing the employment contract, a person starts to systematically train in the duties imposed on them by the organisation. They get to know their subordinates and colleagues: they already met their superiors at the very start. They are in the phase that cannot be critically assessed from the ethical vantage point. The fresh worker is showered with new information. As a result, they have difficulty assessing things in ethical terms and gain some distance.

There is a lot of liberty and sense of personal freedom in an ethical organisation. One can voice their thoughts and views (and criticise others while maintaining good manners and being respectful) without fear of sanctions or harassment. Actions that are surprising and contrary to the workers' will are avoided, people are not held in uncertainty. In addition, workers in such an organisation should avoid actions surprising the employer and causing them trouble. The freedom and the sense of security are facilitated by transparency, a principle applying to everyone.

Ethics organisations ensure that their members enjoy:

- protection against violation of their personal dignity and the need for respect, freedom from rudeness and lack of good manners – in particular, this applies to relations between the employee and their superior. This is so as the superior's evaluation of their subordinate is often expressed in a manner violating the employee's dignity. All employees, even those with poor evaluation results, have the right to experience civil behaviour that complies with the principles of community life;
- freedom from persecution, mobbing and sexual harassment in any form;
- freedom from any discriminatory practices – each employee has the right to equal treatment and access to the same resources and benefits regardless of their religion, sex, age, origin etc.;
- freedom from violation of law and good morals – the organisation cannot use prohibited contractual provisions towards any entities and persons, force its employees to perform unfair competition acts or unfair market practices; the organisation is obliged to create safe and hygienic working conditions and exercise effective supervision over the observance of OHS regulations and the labour law, law of commercial companies etc. being in vigour;
- freedom from burdensome, dehumanised leadership styles – fighting all pathologies (corruption, discrimination, nepotism, glass ceiling, manipulation and other);
- freedom from interference with privacy – each employee has the right to preserving their private life as unavailable to others from their professional environment.

Ethical organisations operate so as to support innovativeness and creativity of the people involved. They do it by accepting the assertiveness of others (clients, workers, subcontractors) and supporting

the professional development of workers – expansion and modification of work content in directions which the workers and the organisation are interested in.

Such organisations create for all their workers conditions for equal opportunity for promotion according to the same far and proper criteria – they do not allow the formation of the so-called glass ceiling.

5.2. Social relations with company / client / environment

5.2.1. Social relations with company

The harmony among the basic human life spheres, professional and non-professional, is the foundation of ethical relations in the company-worker dyad. The time and manner of work cannot be detrimental to the family and reduce it to a secondary social phenomenon. It is best for the work and the family when mutual harmony is sustained and positive signals from both spheres complement each other. Such a phenomenon is referred to as the **Work Life Balance**.

This principle is difficult to maintain in the construction industry. It is often the case that the investments being implemented are located outside the place of residence of workers. This creates the need for working far from home. However, an ethical employee guarantees its workers a regular opportunity to contact their family and home and establishes such terms of rest that ensure comfort and suggests additional benefits such as sports, cultural or social events.

Here attention needs to be drawn to the growing frequency of integration meetings for workers, organised by employers. This is related to creating the involvement atmosphere and the so-called team spirit – the ideal for many organisational cultures. However, participation in integration meetings or charity events of the company should always be voluntary – a worker unwilling to spend their free time in such a way should be able to say no to such events.

5.2.2. Social relations with client and contractors

The quality, innovation and client's satisfaction have taken the first three places in terms of the values that are the most cherished – both in the world and in Poland. The only difference is that in the world the order was quality, innovation and client's satisfaction and in Poland – client's satisfaction, quality and innovation.

Clients cherish the quality of goods and services the most – this also endows quality with an ethical dimension. It is unethical to sell or use products that are defective, dangerous to use, burdensome and costly in upkeep. A service poor in quality and provided negligently is particularly unethical. In terms to service provision, widely understood competences of persons responsible for order execution might be assumed as having a high ethical rank.

As regards client relations, several topics of ethical nature can be listed:

1. Quality of products (goods or services) – the organisation should make an effort for the provided services to be at the highest level or to meet the expectations of the ordering party;

2. Sale contracts – making sure that contractual provisions are fair and reliable, parties' obligations lawful and terms of contracts fulfilled;

3. After sales service, warranty repairs, implied warranties – fulfilment of obligations under the effective law, satisfaction of clients' legitimate interests, care for the good name of clients and the company;

4. Promotion, including advertisement – communication of true information, activities compliant with the principles of fair competition, observance of good manners and good taste, possibility to tell the difference between the facts and the fiction.

As regards contractors and subcontractors:

1. Taking into account reasonable interests of both parties – care for the cooperation terms and conditions to be equally beneficial for the organisation's contractors; avoiding situations where the company's brand and size (including the available resources, e.g. legal services) to force contractual provisions unfavourable for the other party;

2. Settlement of amounts due on time – the problem of payment gridlock impacts nearly a half of businesses in Poland (48%). It most often occurs in the construction and production industries. Therefore, delays in payment settlement are a common phenomenon that hinders operation because only slightly more than a half of receivables are paid on time in the group of companies having problems with obtaining their receivables;

3. Mutual provision of the necessary and true information – avoidance of holding information back or manipulating it;

4. Avoidance of actions surprising the contractors and unfavourable for them.

5.2.3. The essence of corporate social responsibility

Enterprises' attitude to corporate social responsibility (CSR) varies. Most have the sense of duty, but to a limited extent. The problem boils down to the conflict between the enterprise's striving for profit increase and the social interest. Life shows that the enterprises often ignore social interests when striving for higher profitability of the business.

Corporate social responsibility applies to the following relations:

1. Organisation-clients (discussed above)

In this relation, what is the most important is the quality and safety of use of products, warranties and warranty repairs, servicing and satisfaction of other obligations under the contract (see above);

2. Organisation-state

This relation mostly includes payment of taxes, insurance contributions and other effective tax-like charges, which are required for normal functioning of the state and the society, but also the prestige and image of the state. It is unethical to offer workers payment of remuneration "under the table" – such incidents are at least violation of law, or even circumvention of law, to exclude an element or part of remuneration from the tax base and the system of insurance contributions.

3. Organisation-natural environment

This relation ensues in cooperation with the local authorities and other institutions responsible for the environment condition and ecological supervision. Neglects in this area, let alone ecological disasters, are always shocking and have far-reaching consequences. Ecological sensitivity and awareness of the society is growing and organisations' impact on the environment is becoming to be seen as more and more important.

4. Organisation-competition

In the market economy, competition should be protected as it plays an important role in it. Everything degenerates without competition. Even though it is difficult to grasp and understand to many entrepreneurs, they should not strive to destroy their competition. All the more so as competitors are more and more often creating networks of cooperating entities, are participating in joint technical, logistic, marketing and other ventures and – in turn – make profit on it.

In practice, the shaping and harmonisation of all those relations is a complicated process. On the one hand, in such a process an organisation must protect itself against excess in demands and

expectations which may sometimes be threatening its future and existence. On the other, it cannot be egocentric as bad image and enmity of clients, the state or the society towards the organisation are not conducive to its far-reaching interests either.

Time is of essence when discussing ethics. In the short run, people in charge of an organisation may have an impression that unethical behaviour may "be profitable.' This looks different in the long run, though.

Assumptions of CSR in the Erbud Group

The Erbud Group treats CSR as one of the tools for implementation of its long-term development strategy. The CSR activity of the Group aims to build the image of Group Companies obtaining good economic results and being socially responsible and friendly at the same time.

The main areas of sponsoring and social activity:

- the sponsoring and social activity related to the business areas where the Erbud Group Companies operate

Activities taken in this area allow promotion of the business activity of the Group Companies. They are taken for local communities, support for personnel education in areas related to the business activity of the Companies, support for sports activity.

- the sponsoring and social activity performed in agreement with business partners of the Erbud Group Companies.

This area of activity aims to create a positive image of the Group's brands and build their prestige. Our activities in this focus mostly on support for sports and charity activity of our business partners.

- support for the activities of Erbud's foundation WSPÓLNE WYZWANIA im. Eryka Grzeszczaka *(Eryk Grzeszczak COMMON CHALLENGES Foundation).*

The essence of the Foundation is to help young people in difficult life situation who, at the threshold of maturity, face a range of problems related to becoming self-sufficient. The Foundation takes care of the young people leaving Children's Homes in the first place. The assistance is provided in individual form and involves care of the Foundation's mentor for the ward under fostering. The mentors are Erbud Group's workers – the assistance is provided mostly in the form of worker's voluntary service.

Purposes of the actions taken:

- Building a positive image of the Group and individual Group Companies as brands characterised not only by high professionalism in business activities, but also friendly and sensitive towards social and local needs;
- Promoting the Group and the Erbud Group's brands by increasing the degree to which the cycle of business partners are aware of them;
- Reaching environments significant for the Group and the Group Companies and emphasising the magnitude of high standards of undertakings and initiatives organised by the Group;
- Building the Group's and the Group Companies' reputation and acquiring rapport and sympathy of the public eye.
- Supporting promotional and commercial activities of the Group and the Group Companies.

Our activities are focused in the area of activity of companies being members of the Erbud Group.

We support local initiatives as well as nationwide activities.

The Erbud Group does not become involved that could prejudice facilities of historical or artistic merit or in events that could negatively impact the natural environment. Furthermore, it does not become involved in projects related to political activities, serving any discrimination, violating the law or generally accepted social norms or referred to alcohol, addictions and pathology in their theme.

6. References / further reading

6.1. Glossary

(System) fittings – all fixtures of a system such as cut-off, regulation and connecting valves and faucets adapted to the given medium, material of the system and type of joints (e.g. threaded, welded, sealed, flanged)

Mixer tap are a type of fitting that allow taking cold or hot water or water mixed in any proportions.

Occupational Health and Safety (OHS) - a set of terms and rules regarding safe and hygienic performance of work and creating proper work conditions prescribed by the law and built based on experience.

Shower basin – an element of a shower cubicle or a free-standing shower which serves to collect water consumed when showering and drain it to the sewerage system. Instead of basins, watertight bathroom floorings with drainage in the form of floor drain are being used more and more often.

Nominal pressure – producer-declared minimum pressure (provided for water at 20°C) which does not cause deformation or non-tightness of the products such as pipes, couplings, fittings or devices. For media other than water and other working temperature, the value of nominal pressure must be calculated according to proper tables of the producer.

Working pressure – the maximum pressure of e.g. utility water or heating water for which the given system has been designed due to the functionality and parameters of the given building (height). The value of working pressure is the basis for selection of proper system materials and fittings.

CSR (Corporate Social Responsibility) is a concept according to which enterprises, when building their strategy, include social interests, environment protection and relations with a variety of stakeholders.

Cleanout – serves to grant access to a sewerage conduit for its cleaning in the bottom part of the riser.

Operation and maintenance documentation – documentation issued by the producer and determining the purpose, conditions of use and manner of execution of works and use of a system or a device.

Schedule of construction works – it is a document dealing with proper planning of property and financial outlays at the construction site. Schedules of construction works very often form integral parts of contracts concluded between companies participating in construction processes, such as the bank, the Investor or the smallest contracting companies.

HDPE [PE-HD] – high-density polyethylene used in sanitary systems to build sewerage systems with increased chemical and mechanical requirements.

SWPI is a document the purpose of which is to inform about the methods of preventing threats related to the particular type of construction works that require preparation of such a study.

Heating system is set of conduits and devices (boiler rooms, heat distribution centre, pumps, fittings and radiators) serving to heat up buildings.

Water supply system is a set of conduits and fittings which supply water to recipients according to its purpose (utility water, processing water or fire water).

Sewerage system is a set of sewerage conduits in a building along with fittings and equipment serving to discharge household and processing sewage and storm water and to an external collector (a sewerage network or a tank).

Backwater valve serves to protect a building against flooding with sewage from the external sewerage system if it overflows. This protective device is mounted on a discharge conduit (horizontal branch) or a sewerage connection (building drain).

KML is a system of cast-iron sewerage pipes intended for discharge of sewage of increased aggressiveness (coming from gastronomy processes, bathhouses, hospitals, technical rooms, oil discharges).

Codes of ethics (code of good practices) of an XYZ company is an internal document which promotes selected values and fair and ethical practices (of conduct and behaviour), both inside the organisation and in its relations with the external environment, notably with all stakeholders.

Code of professional ethics is a set of principles of conduct, values and ethical norms effective in the given company.

System fitting – a ready-made element of a system allowing connection of pipes with other elements of the system, change in directions etc. Example system fittings are elbows, T-connectors, couplers, nipples, reduction devices, pipe unions, adapters.

Toilet bowl – a piece of bathroom or toilet hardware traditionally made of glazed ceramics, but also from plastics or stainless steel (vandal-proof solution). It may occur as an independent piece of bathroom hardware (standing or suspended bowl) or as an element of the so-called compact water closet, i.e. a bowl integrated with the toilet cistern.

Installation clamps serve to mount pipes to construction partitions. Their structure depends on the diameter and material of the given pipe, the operating parameters of the system and the manner in which it has been laid.

Take-off – specifications determining the type and quantity of individual elements of the given scope of works, made after the completion of works.

The purpose of the **SHP Plan** is identification of all threats related to the works performed at the given construction site as well as determination of solutions to be implemented to prevent them during performance of works.

Supply pipe – a conduit connecting sanitary utensils and devices with a water supply or sewage conduit.

Sewerage connection – a conduit discharging sewage from real property to the external sewerage network or another collector.

Polyvinyl chloride (PVC) is a substance used to create plastics, e.g. pipes and system fittings used in sanitary system. It has thermoplastic properties, it is characterised by high mechanical strength and is resistant to a variety of solvents.

Polypropylene (PP) – is the plastic most commonly used in construction of pipe systems in, inter alia, heating and water supply systems. Polypropylene is a thermoplastic plastic from the polyolefin group and is one of two (the other being polyethylene) most commonly used plastics. Pipes and fittings are produced using polypropylene copolymer (PolyproRylene Random Copolymer) (PP-R).

Diversity policy are guidelines for approach to creating teams in a company. The diversity policy assumes that the employer creates teams composed of people of different sexes, at different age, with different experience and education, representing diverse disciplines of knowledge and speciality, more creative in general.

Water supply connection is a conduit section connecting the water supply source with the water supply devices of the given real property.

Storm water drainage area – an area from which storm water is discharged to the sewerage system.

Bill of quantities – specifications determining the type and quantity of individual elements of the given scope of works, made before the commencement of works.

Design flow is the so-called conventional value of volume stream (e.g. of sewage or water) being the basis for dimensioning of system conduits.

Water supply system conduits serve to distribute water inside real property in a manner allowing intake of water at selected points.

Discharge conduit (horizontal branch) – a conduit for discharge of sewage from risers to the sewerage connection (building drain) or to the local device for waste collection (holding tank, pumping station).

Drain pipe (riser) – a conduit allowing discharge of sewage from sewerage supply pipes (in the case of storm water – from gutters or rainwater drainages) to drainage conduits.

Sanitary hardware includes devices serving to collect and discharge liquid contamination (used water) generated as a result of hygienic and sanitary activities and housekeeping activities. They are the starting elements of the sewerage systems.

Water outlet is a place where water is collected from a system.

Galvanised pipe is a steel pipe protected against corrosion by means of a protective layer of zinc.

Multi-layer pipes from PE-X or PE-RT are the pipes that are the most commonly used in water supply and heating systems.

Gutter is an open conduit collecting precipitation sewage from roof surfaces and discharging it to a drain pipe (riser), from where the sewage flows further to be managed within a plot of land or to the external sewerage network.

SML is a system of sewerage pipes made of cast iron, intended mainly for household sewage and storm water drainage.

Household sewage includes solely municipal sewage, i.e. which is generated from water consumed in household to maintain personal hygiene, flush sanitary devices, prepare meals etc. It also includes sewage from sanitary units in public utility buildings or workplaces.

Industrial/processing sewage – sewage being a by-product of processed used in industry plants and coming from professional meal preparation processes (bars, restaurants). It usually contains various chemical compounds and/or large amounts of fat. Therefore, the require preliminary treatment and/or chemical neutralisation before discharge to the external network.

System routing entails measurements from fixed structural elements of the building and determination of lines/routes through which systems will run.

Washbasin – a part of hardware of bathrooms and other sanitary rooms serving to carry out personal hygienic and sanitary activities (hand and face washing, tooth brushing). Washbasins are most frequently made of glazed ceramics, but they can also be made of plastics, polymers, stone or stainless steel. They most often in occur in the free suspended form, put on tops and bathroom cabinets. However, there are also types for underneath the top, standing etc.

Fittings are devices built in the system that allow control of its operation (control fittings), measurements (measurement fittings) and organised collection of water (outlet fittings).

System user is a natural or legal person who has been appointed to use the given system within a building structure and its surroundings.

Bathtub – a sanitary device for bathing by immersing one's entire body. Traditional bathtubs are made of cast iron, but they are currently being forced out bathtubs made of glass fibre or acrylic. Due to very high water consumption in the bathing process, they are being more and more often replaced by shower cubicles.

Sewerage vent connects the sewerage system with the atmosphere and serves to ventilate the system and equalise pressures.

Gas barriers (traps) protect against gases leaving the sewerage system. The operating principle of the trap is as follows: some water flowing through the trap remains inside, limiting the penetration of gases to the room.

Faucets serve to collect one type of water, i.e. only cold water or only hot water.

Sink – most commonly, this is a functional counterpart of the washbasin, installed in the kitchen or another utility room and serving to perform house-keeping activities (e.g. washing the dishes). In applications outside of the household, sinks can be required in utility, order, production or laboratory rooms, where they serve for the purpose of production processes. Sinks are most commonly made of stainless steel, but due to special process-related requirements (e.g. resistance to chemicals) or functional requirements, they can be made of ceramics, cast iron, stone (granite-resin composite), acrylic and other.

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7. Questions for self assessment

CONTROL QUESTIONS

CHAPTER II

1. What is OHS – explain the abbreviation and provide a short definition.
2. Specify the basic legal act guaranteeing all persons the right to safe and hygienic conditions of performed work is the Constitution of the Republic of Poland.
3. What does “SHP plan” stand for?
4. What is an SHP plan and how is it implemented?
5. What does “SWEI” stand for?
6. What are Safe Works Execution Instructions and when are they implemented?
7. List the places at the construction site the location of which must be known before the works are started.
8. List example precautions used when working at heights (at least 3)
9. List the basic principles of moving around the construction site.
10. List the general requirements for utilisation of construction equipment.
11. List the documents required to begin construction works.
12. List 5 example means of permanent protection measures.
13. List two basic bans related to the observance of the rules of environment protection rules at the construction site.
14. What conditions must a construction site meet if it generates hazardous waste?
15. The activities to be taken at the construction site in the case of an uncontrolled fuel leak.

CHAPTER III

1. List the types of sanitary systems used inside buildings.
2. List the advantages of polypropylene systems.
3. List 3 basic types of polypropylene pipes.
4. What effect does the ambient temperature of below +5 °C have on the duration of PP welding?
5. Can you directly connect elements from carbon steel with stainless steel?
6. Discuss the advantages and disadvantages of water supply systems made from galvanised pipes.

7. Discuss two known connection manners between PE-X or PE-RT multi-layer pipes
8. List the advantages of sanitary sewerage systems made of PVC
9. What diameters do pipes have in commonly used in internal sewerage systems made of PP?
10. Is it allowed to use elbows and tee branching with angle equal to or higher than 90º in gravity sanitary sewage systems?
11. List the advantages and disadvantages of internal sewerage systems made of cast iron
12. List the connection types occurring in HDPE (PE-HD) sewerage systems
13. Discuss the basic differences between the gravitational sewerage system and the vacuum sewerage system (as regards internal rainwater sewerage system made of HDPE)
14. What should you pay special attention to if construction works on drainages are being carried and the executed vacuum roof drainage system is already executed?

CHAPTER IV

1. What elements should a complete executive design of a system have?
2. At which stage of the construction investment are construction cost estimates prepared?
3. What is a bill of quantities?
4. What is the take-off?
5. What is the schedule of construction works?
6. List the activities that are required to prepare a schedule of construction works.
7. What is the routing of internal systems in a building and with what method can it be carried out?

CHAPTER V

1. What is a company's code of ethics?
2. What functions can a code of ethics perform?
3. What is the diversity policy about?
4. Construction workers are most often classified into what groups?
5. What basic ethical standards does an ethically operating company provides its employees with?
6. What is Work Life Balance?
7. What does "CRS" stand for?

ANSWERS:

CHAPTER II

1. What is OHS – explain the abbreviation and provide a short definition.

Answ. Occupational Health and Safety (OHS) - a set of terms and rules regarding safe and hygienic performance of work and creating proper work conditions prescribed by the law and built based on experience.

2. Specify the basic legal act guaranteeing all persons the right to safe and hygienic conditions of performed work is the Constitution of the Republic of Poland.

Answ. The basic legal act guaranteeing all persons the right to safe and hygienic conditions of performed work is the Constitution of the Republic of Poland.

3. What does "SHP plan" stand for?

Answ. Safety and Health Protection Plan.

4. What is an SHP plan and how is it implemented?

Answ. The construction site manager is obliged to prepare or ensure preparation (prior to construction commencement) of a Safety and Health Protection Plan (SHP plan) for construction sites where it is projected that the construction works will be performed *for a period of time exceeding 30 days and, concurrently, at least 20 workers will be hired to perform them and the labour intensity of the planned works will exceed 500 man-days* as well as construction processes involving at least one of the types of works specified below:

- *The nature, organisation or performance site of which gives rise to a particularly high risk of origination of a threat to human safety or life, in particular a cave-in or fall from height;*
- *Performance of which is accompanied by effects of chemical substances or other biological factors posing a threat to human safety and life;*
- *Posing a threat of ionising radiation;*
- *Performed near high voltage lines or active communication lines;*
- *Positing a risk of drowning for the workers;*
- *Performed in well, underground and in tunnels;*
- *Performed by drivers of vehicles powered from overhead lines;*
- *Performed in caissons, with atmosphere produced from compressed air;*
- *Requiring use of explosives;*
- *Performed at installation and disassembly of heavy prefabricated elements.*

5. What does "SWPI" stand for?

Answ. Safe Works Performance Instructions,

6. What are Safe Works Execution Instructions and when are they implemented?

Answ. Based on the SHP Plan, safe works performance instructions, referred to as SWPI, are developed, the purpose of which is to inform about the methods of preventing threats related to the particular type of construction works (specified above) that require preparation of such a study. It is crucial that the provisions of SWPI are presented to and discussed with all workers performing the given type of works, being the subject of the given instructions.

7. List the places at the construction site the location of which must be known before the works are started.

Answ. Prior to commencement of works at the construction site, it is necessary to determine the location of:

- first aid and fire safety point,
- assembly point for evacuation,
- entrance to the construction site,
- construction site office.

8. List example precautions used when working at heights (at least 3)

Answ. In case of works at height, use properly selected means of protection, such as:

- safety harness,
- shock absorption assemblies,
- fall arrest blocks,
- anchoring points,
- barriers.

9. List the basic principles of moving around the construction site.

Answ. At the construction site, move only along the determined passage routes, do not block them with pallets, installation materials or other loads;

10. List the general requirements for utilisation of construction equipment.

Answ. Use equipment meeting the relevant requirements, according to the manufacturer's recommendations provided for in the manual, in a good technical condition;

11. List the documents required to begin construction works.

Answ. The construction works can be commenced only after the following are provided:

- valid medical examination certificates,
- current OHS training (preliminary or periodical),
- current information training and station training at the construction site,
- required licences resulting from the type and nature of performed activities.

12. List 5 example means of permanent protection measures.

Answ. Protective helmet, safety harness, protective shoes, protective glasses, protective earpieces.

13. List two basic bans related to the observance of the rules of environment protection rules at the construction site.

Answ. At all construction sites, it is strictly prohibited to burn trash and mix hazardous waste with non-hazardous waste!

14. What conditions must a construction site meet if it generates hazardous waste?

Answ. In case of contact with hazardous waste, the following must be provided for the construction site:

- Tight and properly marked containers (information and warning signs) secured against effect of external factors;
- Organisation of ecological kits (e.g. sorbent - neutraliser) in case of leakage of a hazardous substance and training workers in terms of use of the said kits;
- Disposal of hazardous waste by an authorised company.

15. The activities to be taken at the construction site in the case of an uncontrolled fuel leak.

Answ. In case of a fuel leakage, do the following as quickly as possible:

a. Secure the area against further uncontrolled spillage using containment measures (e.g. sorbet, sand, etc.),
b. Secure gullies against penetration of the leakage,
c. Remove the spillage using sorbets (according to the manufacturer's instructions).

CHAPTER III

1. List the types of sanitary systems used inside buildings.

Answ. sanitary installations:

- Ventilation,
- Hearing - most frequently, it is still the traditional radiator heating, but it may also have the form of floor heating or with use of various types of heating devices
- Supply and distribution of water for household, fire extinguishing or process purposes
- Storm water system for drainage of rainfall water from roofs and terraces, replacing traditional gutters in larger buildings
- Sanitary and process sewage system for drainage of household wastewater as well as wastewater from all production processes or, for example, commercial preparation of meals
- Heating gas or other process gas, compressed air installations, etc.

2. List the advantages of polypropylene systems.

Answ. Polypropylene is characterised with:

- high hygiene of products (microbiological and physiological neutrality) - it can be used in installations of utility water intended for human consumption,
- high chemical resistance.
- resistance to material corrosion,

- low heat conduction (high thermal insulation of the pipes),
- low specific gravity,
- resistance to scaling,
- absorption of vibrations and flow noises,
- mechanical strength,
- homogeneity of connections,
- high operating durability.

3. List 3 basic types of polypropylene pipes.

Answ. There are 3 types of polypropylene pipes available on the market:

- homogeneous,
- stabilised with aluminium foil, the so-called Stabi Al,
- stabilised with glass fibre, the so-called Glass.

4. How is diameter provided for pipelines made of plastics?

Answ. it must be noted that in the case of pipes made of plastics, the outer diameters of the pipelines and, as the second parameter, the wall thickness of the given pipe (value in milometers) are always specified.

5. What effect does the ambient temperature of below +5 °C have on the duration of PP welding?

Answ. "Note! Extend the heating time by 50% at external temperatures below +5 °C .

6. Can you directly connect elements from carbon steel with stainless steel?

Answ. No. Direct connection of carbon steel elements with stainless steel, aluminium or copper (fittings and couplings) may lead to contact corrosion of galvanised steel. To avoid the above phenomenon, use a brass or bronze separator (e.g. fittings) with the length of at least 50 mm.

7. Discuss the advantages and disadvantages of water supply systems made from galvanised pipes.

Answ. I - Advantages of installation of galvanised water supply pipes:

- high rigidity and, in turn, lower number of fitting points,
- low thermal expansion (i.e. compensation is required for longer sections only),
- high compression and tensile strength,
- resistance to high pressures,

II - Disadvantages of installation of galvanised water supply pipes:

- protection with protective layers which can be easily damaged when threading, screwing, transporting and storing
- the shortest life out of all systems intended for preparation of water supply systems,
- dramatically increased proneness to corrosion when exposed to softened water,

- high roughness index, which increases hydraulic resistances and leads to intensified deposition of scale and sediments on internal walls (reduction in the working cross-section of pipes),
- gradual dissolution of the internal galvanisation layer and contamination of water with it.

8. Discuss two known connection manners between PE-X or PE-RT multi-layer pipes

Answ. Multi-layer PE-X or PE-RT pipes are jointed in two manners – with sleeves clamped at the joint, the so-called radial joint, or sleeves slid on the joint, the so-called axial joint. In the case of the axial joint, the entire joint surface is sealed – the pipe wall is inserted into the notches of the coupling, which secures the highest safety index. In turn, the radial joint is sealed with 1 or 2 O-rings. There is point sealing in this case, i.e. only at one or more sealing devices, depending on the system.

9. List the advantages of sanitary sewerage systems made of PVC

Answ. The advantages of PVC pipes and fittings are as follows:

- full resistance to general and pitting corrosion,
- high smoothness of walls (reduced hydraulic resistances during sewage flow),
- resistance to the harmful effect of chemicals,
- very low weight,
- microbiological resistance,
- thermal resistance reaching (for PVC HT (High Temperature) systems): for continuous flow - up to 75ºC, for momentary flow - up to 95ºC.

10. What diameters do pipes have in commonly used in internal sewerage systems made of PP?

Answ. Magnaplast HTplus is produced for the following outer diameters (in millimetres): 32, 40, 50, 75, 110, 125 and 160.

11. Is it allowed to use elbows and tee branching with angle equal to or higher than 90º in gravity sanitary sewage systems?

Answ. No. "NOTE! In gravity sanitary sewage systems, it is prohibited to use elbows and tee branching with angle equal to or higher than 90º.

12. List the advantages and disadvantages of internal sewerage systems made of cast iron

Answ. Despite multiple advantages offered by the cast iron sewage systems. i.e.:

- high acoustic absorption,
- resistance to temperature changes,
- high durability (including resistance to abrasion),
- stability and invariability of shapes (including increased impact resistance)
- relatively quick fitting of joints,
- possible installation in negative temperatures,

- the high price of the particular elements (pipes and fittings) as well as issues of logistic and installation nature related to the weight of the material (cast iron) result in the low % share of these systems in the modern installations of internal sewage systems.

13. List the connection types occurring in HDPE (PE-HD) sewerage systems

Answ. Joints and fitting of elements
Geberit PE system pipes and fittings can be joined by means of butt welding, electrofusion, or by means of socket, screw and flange connections.

14. Discuss the basic differences between the gravitational sewerage system and the vacuum sewerage system (as regards internal rainwater sewerage system made of HDPE)

Answ. The functioning principle of the vacuum drainage is resigning from the traditional layout of gravity drainage where, according to the standard, in addition to the water drained from the roof, there must be at an least 30% margin for the air stabilising the water flow in the pipeline. The basis of functioning of the vacuum sewage system is assuming 100% filling of the pipelines and generating a vacuum force sucking the water in through the drainages and draining it to the tank at a high speed. Meeting these assumptions allows to significantly reduce the diameters of pipelines and the span of the installation (fewer risers) as well as allows to route the installation without the slope required for the gravity sewage system.

15. What should you pay special attention to if construction works on drainages are being carried and the executed vacuum roof drainage system is already executed?

Answ. Due to a relatively narrow diameter of drainages, it is vital to protect them against clogging during construction. To that end, the drainages supplied to the construction site are equipped with special temporary protective plates, which are to be dismounted after the roof works are completed with simultaneous equipment of the drainage with the target instruments and a protective basket.

CHAPTER IV

1. What elements should a complete executive design of a system have?

Answ. “A complete design study must always include a plan of rooms and the profile or extension of systems covering the ordinates for system routing. In addition, depending on the complexity of the given facility, in the design study the designer can add further drawings such as details of hydraulic hubs, structural details of load-bearing beams, solutions for hard points, solutions for collisions etc.

2. At which execution stage of the construction investment are construction cost estimates prepared?

Answ. Construction cost estimates are prepared at each stage of a construction investment, starting with the estimation of overall costs necessary for the performance of the entire undertaking (e.g. the investor’s cost estimate) and ending with the as-built cost estimate confirming the level of costs sustained for individual executed scopes.

3. What is a bill of quantities?

Answ. Bill of quantities – specifications determining the type and quantity of individual elements of the given scope of works, made before the commencement of works.

4. What is the take-off?

Answ. Take-off – specifications determining the type and quantity of individual elements of the given scope of works, made after the completion of works.

5. What is the schedule of construction works?

Answ. Planning in time of individual construction stages is referred to as the schedule of construction works.

6. List the activities that are required to prepare a schedule of construction works.

Answ. A schedule of construction works (including installation works) is based on the following:

•Determination of the purpose of implementation (the scope of works);

•Determination of tasks necessary to achieve the aim (works comprising the scope of works);

•Determination of the order and time necessary to perform the determined tasks.

7. What is the routing of internal systems in a building and with what method can it be carried out?

Answ. "System routing entails measurements from fixed structural elements and determination of lines/routes through which systems will run – they can be routed with a chalk line or cross-line lasers."

CHAPTER V

1. What is a company's code of ethics?

Answ. Codes of ethics (code of good practices) of an XYZ company is an internal document which promotes selected values and fair and ethical practices (of conduct and behaviour), both inside the organisation and in its relations with the external environment, notably with all stakeholders.

2. What functions can a code of ethics perform?

Answ. The function of codes is twofold: internal and external. The internal function is expressed in striving to promote ethical practices and eradicate unethical practices in one organisation. The external function is expressed in striving to found the relations with external partners on the followed ethical standards and values. This activity may lead to benefit for the given organisation as well as a result of feedback. The external function also entails the shaping of good image of the organisation.

3. What is the diversity policy about?

Answ. Diversity policy are guidelines for approach to creating teams in a company. The diversity policy assumes that the employer creates teams composed of people of different sexes, at different age, with different experience and education, representing diverse disciplines of knowledge and speciality, more creative in general.

4. Construction workers are most often classified into what groups?

Answ. In most companies, there is a division into two closely cooperating employee groups – supervision employees (engineers with a university diploma, foremen, construction work managers,

construction site managers, contract/design managers), who direct the execution of a building structure in a specific place or to a specific extent, and manual labour workers – persons having the skills and qualifications to carry out physical technical activities at the construction site.

5. What basic ethical standards does an ethically operating company provides its employees with?

Answ. Ethics organisations provide their members with:

- protection against violation of their personal dignity and the need for respect, freedom from rudeness and lack of good manners – in particular, this applies to relations between the employee and their superior. This is so as the superior's evaluation of their subordinate is often expressed in a manner violating the employee's dignity. All employees, even those with poor evaluation results, have the right to experience civil behaviour that complies with the principles of community life;
- freedom from persecution, mobbing and sexual harassment in any form;
- freedom from any discriminatory practices – each employee has the right to equal treatment and access to the same resources and benefits regardless of their religion, sex, age, origin etc.;
- freedom from violation of law and good morals – the organisation cannot use prohibited contractual provisions towards any entities and persons, force its employees to perform unfair competition acts or unfair market practices; the organisation is obliged to create safe and hygienic working conditions and exercise effective supervision over the observance of OHS regulations and the labour law, law of commercial companies etc. being in vigour;
- freedom from burdensome, dehumanised leadership styles – fighting all pathologies (corruption, discrimination, nepotism, glass ceiling, manipulation and other);
- freedom from interference with privacy – each employee has the right to preserving their private life as unavailable to others from their professional environment.

6. What is Work Life Balance

Answ. Work Life Balance is the harmony among the basic human life spheres, i.e. the professional and non-professional. The time and manner of work cannot be detrimental to the family and reduce it to a secondary social phenomenon. It is best for the work and the family when mutual harmony is sustained and positive signals from both spheres complement each other.

7. What does "CSR" stand for?

Answ. CSR (Corporate Social Responsibility) is a concept according to which enterprises, when building their strategy, include social interests, environment protection and relations with a variety of stakeholders.