ЈАВНО ПРЕДУЗЕЋЕ
ПУТЕВИ СРБИЈЕ

REPUBLIC OF SERBIA

TRANSPORT REHABILITATION PROJECT

SERBIAN ROAD CONSTRUCTION SPECIFICATIONS

2. SPECIAL TECHNICAL CONDITIONS

2.9 THIRD PARTY SERVICES

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2.9.1 GENERAL

2.9.1.1 Description

Third party services are road construction and maintenance tasks which can be carried out by expert companies trained and authorised for such work.

All considered tasks must be carried out in line with the relevant project documentation, which enables full completion of works, including all services of any other Contractors (Sub-contractors).

If the Contractor provides plans for a third party service, they also have to obtain consent from the Employer or Supervising Engineer, timely, before the works commence.

If certain works of third parties are subject to relevant regulations or special technical requirements, these tasks shall be carried out in accordance with the requirements therein, if the later do not conflict with the requirements determined by the Supervising Engineer.

2.9.1.2 Used materials

All materials which are intended to be used during the performance of third party services must correspond to the requirements of each task, which are defined in the design documentation, and the appropriate technical conditions.

The Contractor may only use material which has been approved by the Supervising Engineer. This is also applicable for each change in the type of material which is envisaged to be used in this part for the considered third party services.

2.9.1.3 Quality of materials

The quality of all materials for third party services must comply with the requirements in the design documentation, relevant regulations and these special technical conditions.

The Contractor must demonstrate the quality of each material which he intends to use in the execution of such works, in line with the requirements of the design documentation, technical conditions and other applicable regulations.

2.9.1.4 Manner of execution

The manner of execution of third party services is defined by the design documentation, relevant regulations and technical conditions.

If defects are found in the design documentation during the execution of works, the Contractor must take into consideration the explanations and work instructions given to him by the Supervising Engineer. These explanations and instructions must be treated as a fundamental part of the design documentation and do not represent a modification of the design.

The Contractor – third party may in agreement with the Employer draw up, within the scope of their authorisation, design documentation for the relevant works. The Contractor must provide appropriate design documentation for each change in the manner of execution of the works, which the Contractor proposes and with which the Supervising Engineer agrees.

If certain works in terms of third party services are not dealt with in these special technical conditions, appropriate technical conditions for their execution must form an integral part of the design documentation, which must be approved by the Employer or – within the boundaries of authorisation - by the Supervising Engineer.

Third party services must be executed in line with the site works progress plan.

The installation of all utility lines into the existing road body should in principle be performed with appropriate hydraulic or pneumatic machinery for penetration or drilling.

A public road and overhead or underground utility lines, as a rule, intersect at an angle of 90° in relation to the carriageway centre line.

In the event that it is not possible to observe the aforementioned angle for justified reasons, the intersection of a public road and utility lines may be constructed at angles between 45° and 135° in relation to the carriageway centre line.

The minimum depth of a utility line outside the road must be in compliance with the provisions in the design rulebook.

Intersections must be constructed according to applicable technical regulations.

It is not permissible to place utility lines in the pavement structure of a public road, except devices for automatic traffic counting or pavement structure condition detectors.

In exceptional cases, within settlements, when conditioned by the existing level of the construction of utility lines, the placement of utility lines in the pavement structure of a public road may be permitted with the preparation of a special design for the demolition and rehabilitation of the pavement structure and the supplementary dimensioning and protection of the utility lines.

The intersection of utility infrastructure with a national road must be constructed through the mechanical drilling of the road so as not to disturb the stability of the road body (pavement, shoulders, embankment slopes). The beginning, i.e. once drilling has been completed, must be carried out so as to construct the foundations of the drilling pit on the inner edge of the land strip and thus include the entire width of the road land with the protective pipe.

The lines in the road body must be placed in special protective pipes that allow for repairs and rehabilitation without excavating the road. The protective pipe must be designed (and installed) along the entire length between the end points of the road cross section (legs of the embankment, or outer edges of the road drainage channel) increased by 3.00 m on each side unless the land strip is wider.

The minimum depth of the installations and protective pipes in question from the lowest upper elevation of the pavement to the upper elevation of the protective pipe is 1.35 m;

The minimum depth of the installations and protective pipes in question below the road drainage channel (existing or planned) from the elevation of the channel base to the upper elevation of the protective pipe is 1.00 m.

For reasons of sight distance, all materials required for this stage of the execution of works must be stored at least 3.0 m away from the road edge or further, if so required because of sight distance.

The construction pit must be properly braced and the pavement must be protected from landslides. At the location of drilling, the Contractor or Employer must carry out works in a way that avoids any reduction in the bearing capacity of the pavement structure.

2.9.1.5 Quality of executed works

The appropriate quality of the executed third party services works, which is defined by the design documentation, regulations and relevant technical conditions, must also be ensured.

The Contractor must in due time before the commencement of works propose to the Supervising Engineer evidence of the quality of all the materials which will be used in the works. The addition of partially damaged elements can be permitted by the Supervising Engineer, if it does not harm the quality of the work in question.

All equipment and machinery used in the execution of the works must be certified and their production capabilities must satisfy the requirements of the design documentation, regulations and technical conditions.

If requested by the Supervising Engineer, the Contractor must before commencing the execution of specific works show, with a demonstrative installation at a location defined by the Supervising Engineer, that he can ensure the quality of the specific work.

The Contractor may only commence the execution of works after having obtained the consent of the Supervising Engineer.

2.9.1.6 Quality control of the execution

The quality of the executed works, which is specified in these technical conditions, must be verified through internal and independent quality control tests in the required scope and manner. The quality of the other executed works within the framework of the third party services must be verified in the scope and manner specified in corresponding regulations or additional technical conditions.

The specifics of checking the quality of executed works are determined by the Supervising Engineer if they have not been defined in the design documentation.

On the completion of works, the Contractor must submit to the Supervising Engineer appropriate evidence that the required quality of the executed works has been met, and the evidence must contain an evaluation of the results of the testing and of the executed works.

2.9.1.7 Measuring and handover of works

Executed works must be measured in line with general technical conditions and calculated in appropriate units of measurement.

All quantities must be measured according to the actual scope and type of works executed, which were performed within the quantity in the design documentation.

On the take-over of executed works the requirements in these special technical conditions must be taken into account. The Contractor must carry out remedial work on all established defects within the deadline, which is determined by the Supervising Engineer.

All costs of rectifying defects fall on the Contractor, including the costs of all tests which demonstrated the inadequate quality of the executed works, and re-testing as required after the appropriate repairs have been carried out to establish the quality of the works.

The Contractor has no right to receive payment for all works which do not meet the quality requirements and which the Contractor did not repair according to the instructions of the Supervising Engineer.

For all installation and assembly types within the scope of third party services, the Contractor must draw up appropriate documentation (geodetic survey and executed works plan) and carry out the transfer into the land register and the public utilities register; a statement from the future operator that all conditions given in the operator's approval for the execution of the works have been met also needs to be acquired.

2.9.1.8 Calculation of works

The fundamentals of the calculation of executed works are specified in the general technical conditions.

All quantities of executed works need to be calculated according to the contractual unit price.

All the services needed for the full completion of the works must be included in the contractual unit price. The Contractor has no right to request later additional payment.

2.9.2 POWER LINES

Electricity can be supplied by means of
- electricity cables and
- over-head power lines.

To build a power line, appropriate design documentation needs to be drawn up and suitable permits from the electric supply company and other institutions obtained.

The route of the power line must be harmonised with the current state of the different installations in the public traffic surface area and with prescribed conditions.
Electricity and other cables cannot be installed underneath the pavement. Their crossings must be executed in such a way that the cable can be replaced without demolishing the pavement.

2.9.2.1 Description

When building power lines connected with the building of roads and road facilities, special requirements for the installation of electricity cables must be taken into consideration
- when installing in parallel,
- when crossing a road,
- when crossing with other lines,
- when crossing a railway track,
- on facilities and
- under water

and for the construction of overhead power lines.

2.9.2.2 Type of material

The following are used for power lines:
- pipes,
- cable shafts
- cable shaft covers and
- cables.

2.9.2.2.1 Pipes

The following types of pipe can be used:
- PC 110 - polyvinyl chloride pipe, external diameter 110 mm,
- PC 160 - polyvinyl chloride pipe, external diameter 160 mm,
- PC 110-EZ – polyethylene pipe, external diameter 110 mm (internal wall smooth, external surface profiled),
- PC 160-EZ – polyethylene pipe, external diameter 160 mm (internal wall smooth, external surface profiled),
- PE 110 - polyethylene pipe, external diameter 110 mm,
- PE 160 - polyethylene pipe, external diameter 125 mm,

PC or PE pipes for cables are circular cross-section pipes, made from hard PC or PE material with appropriate mechanical and other properties. PC pipes must be red in colour.

For pipes directly placed into the ground, the tensile modulus of elasticity (E), measured on the product and the raw material, must be less than 800 N/mm^2, whereas it will be more than 800 N/mm^2 for a pipe drawn into a pipe of the cable network.

All pipes must be marked with the dimensions of the pipes or combinations (d x s in mm), the name of the manufacturer, year of production and length (running metre mark).

2.9.2.2.2 Cable shafts

The following cable shafts can be used
- those of thermo-plastic material,
- those of circular cross-section cement concrete pipes or
- those of cement concrete with a square form, cast in situ or prefabricated.

The size of cable shafts depends on the type and number of pipes and cables.

2.9.2.2.3 Cable shaft cover

Three types of cast-iron covers can be used, dimensioned for 50 kN, 125 kN and 400 kN of point load.

Covers with a bearing capacity of 50 kN can only be used for shafts on green surfaces which are not driven on.

Covers with a bearing capacity of 125 kN can be used for shafts on surfaces which are driven on and where there is a minor load (slabs).
Covers with a bearing capacity of 400 kN can be used for shafts on surfaces which are driven on and where there is a larger load (pavements).

2.9.2.2.4 Cables

Medium voltage and low voltage cables with PVC and PE insulation and with copper or aluminium wires can be used.

2.9.2.3 Quality of materials

The appropriate quality of materials for installation is defined by the design documentation, regulations and relevant technical conditions.

The Contractor must in due time before the commencement of works submit to the Supervising Engineer evidence of the quality of all the materials which will be used in the works.

The Contractor may only commence installing the materials after having obtained the consent of the Supervising Engineer.
The quality of the material needs to be checked on the basis of technical information for the product and accompanying documents (ordering form, certificates, declarations).

Before laying the cables, it is necessary to measure the cables on drums and measure the dielectric strength and insulation resistance.

2.9.2.4 Manner of execution

2.9.2.4.1 Installation of power cables

2.9.2.4.1.1 On a free surface

The installation depth of a cable depends on the rated voltage in the cable, given in table 2.9.1.

Table 2.9.1: Minimum installation depth of a power cable

Rated voltage [kV]	Minimum cable depth [m]
1	0.7
10	0.8
20	1.0
35	1.0
110	1.2

Width of the bottom of the trench for power cables with a rated voltage of:
- 1 kV and 10 kV 0.4 m,
- 20 kV and 35 kV 0.5 m.

The power cable trench must be at least 0.5 m from the foundations of a structure and at least 2 m from a tree.

A layer of loose mineral sand aggregate 0/4 mm of a thickness of approximately 10cm must be placed and levelled at the bottom of the trench.

If the installation of power cables is done by machinery, it must be ensured through the use of appropriate measurements (with a dynamometer) that the permissible tightening force is not exceeded.

The lowest recommended temperature (+5 ^{0}C) and the instructions of the cable manufacturer must be taken into consideration when uncoiling and installing power cables.

The minimum permitted bending radius, given in table 2.9.2, or in line with the cable manufacturer's instructions, must be taken into consideration when uncoiling and laying power cables.

Table 2.9.2: Minimum bending radius of a power cable

Type of cable	Rated voltage [kV]	Impregnated cable		Thermo-plastic cable	
		Lead sheath	Aluminium sheath	PVC sheath	EP XP sheath
		minimum permitted bending radius			
single-core	1 to 35	25 D	30 D	20 D	15 D
multi-core cable	1 to 10	15 D	25 D	12 D	10 D
	20 to 35	15 D	25 D	15 D	12 D

D is the external diameter of the cable in mm.

A layer of mineral sand aggregate 0/4mm, a minimum of 10 cm thick, must be placed above the power cable.

Additional mechanical protection (plastic shield) must be placed above the cable or soil material.

Approximately 40 cm above the cable, a red warning strip of soft PVC with the inscription "WARNING POWER CABLE" must be placed.

An earth strip must be placed above the power cable – Fe/Zn strip 25 x 4 mm.

2.9.2.4.1.2 Parallel installation

The minimum depth of the trench for parallel power cables is the same, as given in table 2.9.1. Signal cables must be placed into the ground at a depth of 0.6 to 0.8 m.

The required width of the bottom of the trench for parallel cables is specified in table 2.9.3.

The minimum permitted distances between the parallel power cables and other cables are given in table 2.9.4.

Table 2.9.3: Minimum trench width for parallel power cables

Number of cables	Rated voltage of cable	
	1 kV and 10 kV	20 kV and 35 kV
	width of bottom of trench (m)	
2	0.4	0.6
3	0.6	0.9
4	0.8	1.3
5	1.0	1.6

Table 2.9.4: Minimum distance between parallel power cables

Type of cable	Minimum distance (m)
signal next to signal	-
telephone next to telephone	-
signal next to telephone	0.05
power:	
two power cables of up to 1 kV	0.07
10 kV with a lower voltage cable	0.15
20 kV and 35 kV with another power cable	0.2
cable of up to 1 kV with a telephone cable	0.3
10 kV with telephone cable	0.5
cable of above 10 kV with telephone cable	1.0*

* with additional thermal protection

2.9.2.4.1.3 At road crossings

At crossings with a road and in all other places where a greater mechanical load and mechanical damage can be expected, power cables must be installed in appropriate cable ducting. These can be built from thermoplastic pipes with appropriate component parts.

Cable ducting must be built as perpendicular as possible to the road centre line, at a distance of at least 1m on each side outside the carriageway.

The width and depth of the trench for cable channels depends on the number of cables and pipes which can be installed on a single level or several levels.

The upper edge of the highest pipe must be at least 0.8 m below the elevation of the pavement.

In the event of long cable ducting, appropriate shafts need to be built. The distance between them depends on the cable type and diameter. Shafts need to be built wherever the ducting direction changes and where it crosses with a road. The size of the shafts depends on the number and the diameter, and the rated voltage of the cables, as well as on the permitted bending radius and working conditions. The minimum inlet opening into the shaft is 0.60 x 0.60m, and double cast iron cover with a crossbar that can be removed should be used for larger shafts. There must be an opening for drainage at the bottom of the shaft and step irons on the wall.

2.9.2.4.1.4 At crossings with other lines

To exclude interference and damage when power cables cross or near other utility lines the minimum required distance must be taken into account. The minimum required distances of power cables from other lines and devices are given in Table 2.9.5.

Table 2.9.5: Minimum clear distance of power cables from other lines / devices

Type of line / device	Minimum clear distance of power lines	
	electricity line [m]	at crossing [m]
telecommunications line	0.5 to 2.0	0.5
water pipeline	0.5 to 2.0	0.5
gas pipeline	1.0	0.6
oil pipeline	1.0	0.5
hot water system:		
from signal and 1 kV cables	1.0	0.3
from 10 kV to 35 kV cables	0.7	0.6
from 60 kV cables	1.5	1.0
sewerage	0.5	0.5

2.9.2.4.1.5 At crossings with a railway

A power cable must be placed in a thermo-plastic or metal pipe, with adequate resistance to mechanical impacts when crossing with a railway track. The aforementioned pipes must be installed in such a way that it is possible to replace the cable with needing to excavate.

If a power cable crosses with an electrified railway, the protective pipes must be of a non-conductive material, which must be appropriately additionally processed (thermoplastic pipes). The crossing of a power cable with a railway must be executed at a right angle and at least 1 m below the elevation of the top of the rails.

When a power cable crosses with a railway, the area must be visibly marked (cement concrete or stone marker).

2.9.2.4.1.6 On facilities

As a rule, when passing through facilities, a power cable must be placed in special pipes or channels (fire-resistant material), which are installed in the structure in the footpath or on girders, where the cable must be appropriately mechanically protected.

The cable, which is installed in pipes or channels in the structure, cannot have an inflammable covering (e.g. jute).

The use of joints for joining cables in the structure is not permitted. This also applies in the vicinity of the object due to ground vibrations.

If vibrations are expected on the structure, vibration-resistant power cables should be used.

Cables on cement concrete structures, which are reinforced with steel, or on steel structures, which also have electrified railway tracks, must be placed in such a way that they do not come into contact with the metal parts of the structure or the steel used to reinforce the cement concrete structure.

2.9.2.4.1.7 Underwater

If the bed of the flowing water does not significantly change shape, it is possible to lay a power cable directly on it.

An underwater power cable must be placed at a suitable distance from structures, moorings and similar locations where it could be damaged.

An underwater power cable must cross the watercourse at its narrowest point. The authorised water authority, as a rule, defines the method of intersecting a watercourse with a power cable. The location where cables cross navigable waterways must be appropriately marked.

2.9.2.4.2 Construction of overhead power lines

Reinforced cement concrete posts and metal towers for high-voltage power lines, and metal strips on wooden poles, which are to provide protection from lightning strikes, must be earthed.

Posts for high-voltage power lines and wooden poles for high-voltage power lines, which do not have metal strips for earthing, do not need to be earthed, nor do they require any other protective measures.

Safety height and safety distance must be taken into account at the crossing of an overhead power line and when they are located close to various kinds of structures. Values for specific examples are given in Table 2.9.6. Where the safety height distance value is not given in Table 2.9.6, the value given for safety distance needs to be taken into consideration.

Table 2.9.6: Minimum safety height and distance from nearby locations / facilities

Location - structure	Safety height	Di1stance M
inaccessible location	4	3
location inaccessible to vehicles	5	4
location accessible to vehicles:		
for high-voltage power lines up to 110 kV	6	5
for low-voltage power lines	5	4
Buildings		
inaccessible location (roof, chimney, etc)		
for high-voltage power line up to 110 kV (above ridge)	-	3
consistently accessible locations (terraces, balconies, scaffolding etc):		
for high-voltage power lines up to 110 kV	5	4
for low-voltage power lines	2.5	1.25
with inflammable roofing		
for high-voltage power lines up to 110 kV	12	5
Settlements		
for high-voltage power lines up to 110 kV	7	-
for low-voltage power lines	5	-
Sports grounds		
for high-voltage power lines up to 110 kV (exceptionally)	-	12
Forests and trees		
for high-voltage power lines up to 110 kV	-	12
for low-voltage power lines	-	1
Regional, local and lower importance roads:		
for high-voltage power lines up to 110 kV	7	10 (5)
for low-voltage power lines	6	-
Main roads:		
for high-voltage power lines up to 110 kV	7	20 (10)
for low-voltage power lines	6	2
motorways:		
for high-voltage power lines up to 110 kV	7	40 (10)
for low-voltage power lines	6	-
motorways – running in parallel for a section longer than 5 km:		
for high-voltage power lines up above 35 kV	-	10
for high-voltage power lines up to 35 kV	-	50
rivers for rafting (above highest water level)	7	-
navigable rivers and canals	15	10
navigable rivers and canals – running parallel for a section longer than 5 km		
for high-voltage power lines (from the banks)	-	50
bridges and other facilities	-	5

For power lines with a rated voltage of 220 kV, the safety height and safety distance should be increased by 0.75, and 2 m from the value for 110 kV for power lines with a rated voltage of 400 kV.

When a high-voltage power line passes over another high-voltage power line of up to 110 kV, the safety height must be 2.5 m and the safety distance 1 m.

When a high-voltage power line of up to 110 kV passes over a low-voltage power line, the safety height must be 2.5 m and the safety distance 2 m.

At the point where an overhead power line passes over telecommunications line, the safety height between the lowest wire of the power line and the highest wire of the telecommunications line must be as follows:
- for high-voltage 400 kV 5.5 m
- for high-voltage 220 kV 4.0 m
- for high-voltage above 35 kV to 110 kV
- for high-voltage above 1 kV to 35 kV 2.5 m
- for high-voltage above 250 V to 1 kV 2.0 m
- for low-voltage up to 250 V 1.0 m

Where telecommunications and overhead power lines run close to one another, the horizontal distance between the closest wires is equal to the height of the highest post, increased by 3 m.

If gas pipelines, oil pipelines, steam pipelines and other similar installations are laid on the ground, the safety height and safety distance for low-voltage power lines must be 2.5 m and 8.0 m for high-voltage power lines of up to 110 kV. In cases of parallel running, the safety distance may not be less than the height of the pylons increased by 3 m.

Overhead high-voltage power lines cannot cross airports, cannot come within 1,000 m of the runway and cannot cross its direction at a distance of less than 3,000 m.

The safety height between the wires and the top of the rails of an electrified railway must be 12 m, the horizontal distance of the posts from the rails must be at least 15 m.

The choice and calculation of posts, their foundations and the installation of posts must be done in line with relevant regulations.

2.9.2.5 Quality of execution

The works carried out in the construction of cable ducting must be of an adequate quality, which is defined by the design documentation, regulations and relevant technical conditions.

The Contractor must in due time before the commencement of works submit to the Supervising Engineer evidence of the quality of all the materials which will be used in the works.

All equipment and machinery used in the execution of the works must be certified and must satisfy the requirements of the design documentation, regulations and technical conditions in terms of capacity.

The Contractor may only commence the execution of works after having obtained the consent of the Supervising Engineer.

2.9.2.6 Quality control of the execution

After the completion of the cable ducting and after the completion of other construction works, the transiency of the pipes must be inspected.

After the construction of the cable shafts has been completed, it is necessary to inspect the execution of the inlets (smoothed concrete), drainage and protective net against rodents.

After the cables have been laid, it is necessary to measure resistance, perforation resistance and insulation resistance. The measuring must be conducted in line with applicable technical regulations and standards. Measuring can only be performed by companies registered to do so. A written report containing the results must be compiled for all measurements. The report must make it clear whether the results of the measuring are acceptable or not. Written records must be kept for all reports.

2.9.2.7 Measuring and take-over of works

Executed works must be measured in line with general technical conditions and calculated in appropriate units of measurement.

All quantities must be measured according to the actual scope and type of works executed,

which were performed within the quantity in the design documentation.

2.9.2.8 Calculation of works

The fundamentals of the calculation of executed works are specified in the general technical conditions.

All quantities of executed works need to be calculated according to the contractual unit price.

All the services needed for the full completion of the works must be included in the contractual unit price. The Contractor has no right to request later additional payment.

2.9.3 TELECOMMUNICATION LINES

Telecommunication (TC) lines are
- overhead TC lines,
- buried cable TC lines and
- telephone cable ducting.

Adequate investment and technical documentation must be drawn up for the construction of TC lines in line with the instructions and regulations for designing and building TC lines and appropriate permits must be obtained.

The route of TC lines must be harmonised with the current state of the different installations in the public traffic surface area and with prescribed conditions.

TC lines cannot be built underneath the pavement. Their crossings must be executed in such a way that the cable can be replaced without demolishing the pavement. The cable must be laid in previously constructed cable ducting.

2.9.3.1 Description

2.9.3.1.1 Overhead TC lines

The construction of an overhead TC line entails:
- marking out,
- acquisition and installation of supports (poles, equipment, insulators, protective devices, including all necessary works),
- acquisition, installation and fastening of lines and other devices and
- entry into the register of public utility lines.

When selecting the optimal solution, the following must be taken into account:
- that the overhead TC line is easily accessed at all times,
- that the length of the overhead TC line is as short as possible,
- connection is simple.

The aforementioned conditions are met if the overhead TC line is built along a road or a railway track.

2.9.3.1.2 Buried cable TC line

The construction of a buried cable TC line entails:
- marking out,
- acquisition and laying of the cable and cable protection, including all required earthworks, and
- entry into the register of public utility lines.

2.9.3.1.3 Telephone cable ducting

Telephone cable ducting comprises:
- ducting pipes,
- cable TC lines and
- cable shafts.

Pipes made of thermoplastic material, smooth or ribbed, are suitable for telephone cable ducting.

The construction of telephone cable ducting must entail:
- marking out,
- all necessary earthworks (excavation and backfilling of trenches, terrain arrangement),
- execution of substrate,
- acquisition and laying of pipes and the construction of shafts,
- acquisition, laying and connection of cables, and
- entry into the register of public utility lines.

Telephone cable ducting must
- be primarily built into footpaths and non-driving areas,
- have as few shafts as possible and
- be placed at a specific distance from other underground lines.

2.9.3.2 Type of material

The following are used for TC lines
- pipes,
- cable shafts,
- cable shaft covers and
- cables.

2.9.3.2.1 Pipes

The following types of pipe can be used:
- PC 110 - polyvinyl chloride pipe, external diameter 110 mm
- PC 125 - polyvinyl chloride pipe, external diameter 125 mm
- PC 110-EZ - polyethylene, external diameter 110 mm (internal wall smooth, external surface profiled)
- PC 125-EZ - polyethylene, external diameter 125 mm (internal wall smooth, external surface profiled)
- PE 110 - polyethylene pipe, external diameter 110 mm
- PE 125 - polyethylene pipe, external diameter 125 mm,

PC or PE pipes for cables are circular cross-section pipes, made from hard PC or PE material with appropriate mechanical and other properties. PC pipes must be yellow in colour and PE pipes black in colour.

The following small diameter pipes can also be used:
- PE 40 - polyethylene pipe, external diameter 40 mm,
- PE 50 - polyethylene pipe, external diameter 50 mm,
- 2x PE 50 - double polyethylene pipe - coupled, diameter 2x50 mm.

Small diameter PE pipes are inserted into the pipe of an existing or new TC cable duct or are laid directly into the ground. They are intended for the installation of telecommunications cables.

For pipes directly placed into the ground, the tensile modulus of elasticity (E), measured on the product and the raw material, must be less than 800 N/mm^2, whereas it will be more than 800 N/mm^2 for a pipe drawn into a pipe of the cable network.

All pipes must be marked with the dimensions of the pipes or combinations (dxs in mm), the name of the manufacturer, year of production and length (running metre mark).

The same provisions and measures for a single 50 mm pipe apply to a coupled 2x50 mm pipe.

2.9.3.2.2 Cable shafts

The following cable shafts can be used
- those of thermoplastic material,
- those of circular cross-section cement concrete pipes or
- those of cement concrete with a square form, cast in situ or prefabricated.

The size of cable shafts depends on the type and number of pipes and cables.

2.9.3.2.3 Cable shaft covers

Three types of cast-iron covers can be used, dimensioned for 50 kN, 125 kN and 400 kN of point load.

Covers with a bearing capacity of 50 kN can only be used for shafts on green surfaces which are not driven on.

Covers with a bearing capacity of 125 kN can be used for shafts on driving surfaces with a smaller load (tiles).

Covers with a bearing capacity of 400 kN can be used for shafts on driving surfaces with a higher load (pavements).

The covers must be marked with the inscription TELEPHONE.

2.9.3.2.4 Cables

TK 59…. cables can be used for local connection and TD 59... cables and optical cables for intercity connections.

2.9.3.3 Quality of materials

The appropriate quality of materials for installation is defined by the design documentation, regulations and relevant technical conditions.

The Contractor must in due time before the commencement of works submit to the Supervising Engineer evidence of the quality of all the materials which will be used in the works.

The Contractor may commence installing the materials only after having obtained the consent of the Supervising Engineer.

The quality of the material needs to be checked on the basis of technical information for the product and accompanying documents (ordering form, certificates, declarations).

Before laying cables, they must be measured on drums for weakening (with an OTDR device), for insulation resistance and dielectric strength.

2.9.3.4 Manner of execution

2.9.3.4.1 Overhead TC line

An overhead TC line must be built with an adequate self-supporting cable.

The shape of pole pits for overhead TC lines depends on the type of material in the soil and on the height of the poles. In category 3, 4 and 5 material (as per these technical conditions), the shape of the pit must be

- cylindrical for poles between 6 and 7 m high,
- rectangular for poles between 8 and 12 m high, with one bench,
- rectangular for poles above 12 m high, with two benches.

The required depth for burying poles is given in 2.9.7.

Table 2.9.7: The required burying depth of poles for overhead TC lines

Material category	Height of pole [m]						
	6	7	8	9	10	11	12
3	1.4	1.5	1.7	1.9	2.1	2.2	2.3
4	1.2	1.3	1.5	1.7	1.8	1.9	2.0
5	0.9	1.0	1.2	1.3	1.4	1.4	1.5

Poles need to be fixed into the pits with backfill material, compacted into layers by machine or manually. The conical elevation needs to be approximately 20 cm above the elevation of the ground.

Equipment, insulators, protection devices and lines need to be installed according to the guidelines in the design documentation.

On the end supports and at the transition of an aboveground TC line into a cable TC line, surge arrestors and adequate earthing must be provided.

Overhead TC lines may not be built at a distance of less than 20 m from the edge of the carriageway along motorways and roads, which are intended exclusively for motor vehicles. Along other roads, the distance cannot be less than the height of the poles.

The safety height between the ground and the lowest wire of an overhead TC line may not be less than 5 m in the most unfavourable of conditions.

TC lines on bridges, overpasses, viaducts and tunnels must be built using cables and in specially designed channels. If no such channels are available, the cable must be routed along the outer lateral side of the bridge, overpass or viaduct, or in the footway in the tunnel and protected appropriately.

If an overhead TC line is built alongside another TC line, the distance between the two lines must be at least 15 m.

If an overhead TC line is built alongside a electricity transmission line, the horizontal distance between the closest wires of those lines must at least be equal to the height of the highest poles, increased by 3 m. If this is not possible, the distance can be at least 1 m for voltage 250V towards the ground and 4 m for higher voltages.

Special procedures, which aim to increase safety, must be used when TC lines cross a road, railway line, river, other TC lines and exceptionally over low-voltage power lines (with a voltage of up to 250V towards the ground). TC lines are not permitted to cross over higher voltage power lines.

In order to ensure unhindered traffic, the safety heights of the lowest wire of an overhead TC line above the road surface when crossing roads, in the most unfavourable of conditions, are:

- at least 7 m for motorways, main roads and regional road,
- at least 4.5 m for other roads.

When crossing with another overhead TC line, the minimum safety height between the lowest upper line and the highest wire of the lower line is 0.6 m.

When crossing over a navigable river, canal, reservoir and similar water surfaces, the

safety height of the lowest wire of the TC line from the water level must be determined in such a way that vessels can pass safely when the water level is at its highest.

Besides safety heights, attention should also be paid to the crossing angle and the length of the crossing span.

The most favourable crossing angle is 90° and the minimum angle is 45°, and the longest span is 60 m. If the crossing span exceeds 60 m, a crossing with an appropriate underground cable must be made.

In terms of the crossing span, care needs to be taken
- that the horizontal distance of the support of an overhead TC line from the closest power line is not less than 5 m; this is not a requirement when the height difference between the closest wires of both lines is at least 10 m.
- that the horizontal distance of the support of a power line and the nearest wire of an overhead TC line is not less than 2 m.

When crossing with power lines, the safety height between the lowest wire of the power line and the highest wire of the overhead TC line are as follows:

for voltages of 400 kV	5.5 m,
for voltages of 230 kV	4.0 m,
for voltages of 35 kV to 110 kV	3.0 m,
for voltages above 1 kV to 35 kV	2.5 m,
for voltages above 250 V to 1 kV	2.0 m,
for voltages up to 250 V	1.0 m.

2.9.3.4.2 Buried cable TC line

The width and shape of the ditch for cable TC lines depend on the type of material in the ground and on the number of cables:
- the ditch must be 15 to 25 cm wide for 1 to 2 cables
- the ditch is widened by a further 5 cm for each additional cable.

Cable shafts should be built at locations where the execution of joints is specified in the design documentation.

The depth of the ditch depends on the type of cable and type of material in the ground. As a rule, the depth must be 1 m. The ditch must be at least 1.2 m deep through settlements and arable agricultural land if no mechanical protection for the cable lines is envisaged and there are no underground lines.

The construction of passages under roads and over canals and bridges must be completed before the laying of cable TC lines in the ditch.

A cable TC line, as a rule, must be laid in the middle of the ditch. A loose layer of mineral sand aggregate 0/4 mm, slightly convex and 10 cm in thickness, must be placed at the bottom of the ditch.

When backfilling the ditch, the thickness of the 0/4 mm mineral sand aggregate must be at least 10 cm above the cable, if it is protected, or at least 15 cm if there is no protection.

The rest of the ditch can be filled with the material excavated from the ditch, in 15 to 20 cm thick layers. The first layer may not contain pieces of brick, larger stones or other coarse-grained material, and is placed manually and a slightly compacted. Outside settlements, where protection is not envisaged as a rule, the thickness of the first layer must be at least 15 cm. Other layers must be spread and compacted by means of machinery or manually.

The covering material for cables should be placed over the layer of 0/4 mm mineral sand aggregate. A protective PVC angle bar must be used to protect the cables and a yellow warning plastic strip with the inscription "ATTENTION TC CABLE".

Protective pipes for a buried cable TC line must be placed in the following cases:
- when crossing with a public road, railway tracks and canals,
- when the required minimum distance from specific facilities has not been met,
- when in proximity to power lines and when crossing power and telecommunications cables.

The minimum clear distances of telecommunications lines from nearby lines, devices and facilities are given in Table 2.9.8.

Table 2.9.8: Minimum clear distance of telecommunications lines from nearby lines, devices and facilities

Type of line, device, structure	Minimum clear distance of TC line [m]	
	Parallel course	At crossing
power cables with a voltage:		
of up to 10 kV	0.5	0.5
of up to 35 kV	1.0	0.5
over 35 kV	2.0	0.5
water supply (with a pipe diameter of up to 200 mm), sewerage system, hot water supply and gas pipe	1.0	0.5
supporting structure of a contact line and traffic light	10.0	-
supporting structure of an overhead TC line	2.0	-
regulation line of buildings in settlements	0.6	-
tram tacks	2.0	1.0
Toe of railway track,		-
road and motorway fill	5.0	-
installation and reservoir with inflammable and explosive fuel	1.5	-
TC ducting and shaft	0.5	0.15
supporting structure of a power line with a voltage of:		
1 kV: -without mechanical protection	0.8	-
with mechanical protection	0.3	-
more than 1 kV, without direct earthing:		
at unearthed wooden supporting facilities	0.8	-
at concrete and steel earthed supporting facilities	0.5	-
more than 1 kV, with direct earthing:	15.0	-

A cable must be protected by inserting it into plastic pipe or semi-pipe and by casting. The length of the pipe on both sides of the crossing or nearing point cannot be less than 0.5 m.

When a cable runs parallel with or nears underground or above ground facilities, the distances given in Table 2.9.8 must be respected.

Telecommunications cables running parallel with electricity transmission cables should be avoided; if this is not possible, the distance between the cables must not fall below the prescribed distance (depending on the type of power cables) and regulations regarding the protection of power lines for electricity transmission must be taken into consideration.

When a cable route crosses with an underground structure, a distance of 0.5 m should be ensured, or 0.15 m in the case of cable TC ducting, which should be protected as appropriate.

When a cable crosses with roads, the most favourable crossing angle is 90°. If it is not possible to achieve this angle, a crossing can be executed at another angle as long as it is not below 45°. Appropriate protection should be used when constructing crossings.

2.9.3.4.3 Telecommunications cable ducting

Cable ducting is a network of underground plastic pipes which are laid in groups of 1x2, 2x2 etc in an open trench. The pipes must be laid in 0/4 mm mineral sand aggregate mixture and backfilled with the same mineral mixture, both in 10-cm layers above and below the edge of the pipe, the rest of the backfill must be performed with the excavated material up to the top, in compacted layers. The minimum distance from the top of the upper pipe to the ground

level must be 0.5 m and to the asphalt pavement surface 0.8 m.

Certified PVC pipe with the measurements 110/103.6 mm and PEHD pipes with the measurements 110/97.6 mm must be used. In order to ensure the same distance between pipes, spacers must be used, which have to be assembled in line with the manufacturer's instructions.

In the event that the distances between the upper pipes and the surface of the ground are less than those prescribed, the pipes must be cast. If the distance is less than 30 cm, the upper layer is made from reinforced cement concrete, and pipes with a thicker wall are used.

When crossing a road, the upper part of the edge is cast with cement concrete C 8/10 to a thickness of 30 cm. A PVC warning strip with the inscription "ATTENTION TC CABLE" (1-2 strips, 30 cm above the pipe) must be laid above the pipe.

This construction of cable ducting enables existing cables to be quickly and easily replaced, the capacity of the network to be easily increased and future repairs to be carried out without having to dig up the surface again.

The following can be used in cable ducting construction:
- PC 110 pipe, external diameter 110 mm,
- PC 110 - EZ - polyethylene, external diameter 110 mm (internal wall smooth, external surface profiled).

Pipes must be made in line with applicable regulations and standards currently applicable in the Republic of Serbia and in line with the requirements of the standard DIN 8062 for unplasticised polyvinyl chloride (uPVC) pipes and in line with the requirements of the standards DIN 16961, DIN 8062, DIN 8074 and NFC 68-171 for polyethylene (PE) pipes.

When telecommunication ducting approaches or crosses with other underground installations, the prescribed distances and the angles of crossing must be adhered to the minimum permitted distance between a telecommunications cable duct and an electric cable is as follows:
- approaching:
- low-voltage cable 0.5 m
- high-voltage cable 1.0 m
- when crossing with a LV and HV cable (crossing angle 45° - 90°):
- 0.3 m without protective measures.

Protective measures must be executed at a length of 0.5 m on each side of the crossing.

The distance of telephone cable ducting from a transmission line pylon is 10 m; if it is not possible to respect this distance, in settlements, a distance of at least 1 m for a transmission line of up to 35 kV is necessary.

Distances between telephone cable ducting and other installations depend on their dimensions and lengths and normally come to:
- from sewage system
  approaching 1.0 m;
  crossing 0.5 m;
- from water supply
  approaching 1.0 m;
  crossing 0.5 m;
- from gas pipeline (1 to 16 bars)
  approaching 0.4 - 0.6 m;
  crossing 0.4 m;
- from insulating tape 0.3 m.

2.9.3.4.4 Cable shafts

In accordance with cable ducting, cable shafts must also be envisaged at locations where TC cables branch off or at locations of cable joints. They are used for connecting cables, inserting cables into pipes and the possible installation of cable equipment.

In line with the instructions of the local operator, the dimensions of cable shafts depend on the number of pipes and come to 1.1x1.8x1.9 m (1.5x1.8x1.9 m) for 4 pipes to 1.8x2.5x1.9 m for 6 to 12 and more pipes. It is possible to construct a cable shaft with the dimensions 1.2x1.2x1.2 m for lower numbers of pipes or as a transitional cable shaft. Smaller cable shafts of Φ60 and Φ80 cement concrete pipes may be used as auxiliary shafts.

2.9.3.5 Quality of execution

The works carried out in the construction of cable ducting must be of an adequate quality, which is defined by the design documentation, regulations and relevant technical conditions.

The Contractor must in due time before the commencement of works submit to the Supervising Engineer evidence of the quality

of all the materials which will be used in the works.

All equipment and machinery used in the execution of the works must be certified and must satisfy the requirements of the design documentation, regulations and technical conditions in terms of capacity.

The Contractor may only commence the execution of individual phases of the works after having obtained the consent of the Supervising Engineer.

2.9.3.6 Quality control of the execution

2.9.3.6.1 Cable ducting using small diameter PEHD pipes

After the completion of the cable ducting and after the completion of other construction works, the quality of the executed cable ducting with small diameter pipes must be inspected.

The following must be inspected or tested:
- transiency,
- flatness
- curvature and
- air passage and
- cleanliness of the pipes.

The inspection of the quality of cable ducting must be, as a rule, carried out with a calibrator.

Calibration of pipes must be performed between cable shafts at a length of approximately 500 m.

Testing must be carried out in line with the regulations of German Telecom ZTV-FLN 40.

2.9.3.6.2 Smooth and ribbed PVC pipe cable ducting

After the completion of the cable ducting and after the completion of other construction works, the quality of the execution of the cable ducting - pipe transiency - must be inspected.

2.9.3.6.3 Cable shafts

After the construction of the cable shafts has been completed, it is necessary to inspect the execution of the inlets (smoothed cement concrete), drainage and protective net against rodents.

2.9.3.6.4 Cables

After laying cables, it is necessary to measure loop resistance, weakening, dielectric and insulation resistance.

The weakening of optical cables must be measured with an OTDR device.

Measuring must be conducted in line with applicable technical regulations and standards. Measuring can only be performed by companies registered to do so. A written report containing the results must be compiled for all measurements. The report must make it clear whether the results of the measuring are acceptable or not. Written records must be kept for all reports.

2.9.3.7 Measuring and take-over of works

Executed works must be measured in line with general technical conditions and calculated in appropriate units of measurement.

All quantities must be measured according to the actual scope and type of works executed, which were performed within the quantity in the design documentation.

2.9.3.8 Calculation of works

The fundamentals of the calculation of executed works are specified in the general technical conditions.
All quantities of executed works need to be calculated according to the contractual unit price.

All the services needed for the full completion of the works must be included in the contractual unit price. The Contractor has no right to request later additional payment.

2.9.4 SOS TELEPHONES

The SOS Telephone system is intended to be used by drivers on motorways and maintenance personnel to establish communications from certain locations along the motorway with the competent motorway base or its office. The safety and lives of drivers on motorways depends on the uninterrupted functioning of this system. Therefore, the technical designs must ensure the uninterrupted functioning of the SOS telephone system regardless of the various

environmental conditions. The system is intended for users who need help in the event of an accident or vehicle breakdown.

Appropriate design documentation must be drawn up for SOS telephone construction in line with the instructions and regulations for designing and building and appropriate permits must be obtained. The route must be harmonised with the current state of the different installations in the public traffic surface area and with prescribed conditions.

2.9.4.1 Description

2.9.4.1.1 Composition of the SOS telephone system

The SOS telephone system must be composed of the following equipment and installations with the following requirements:

- six-pipe cable ducting of 50-mm diameter PEHD pipes (3 pipes 2x50 mm), which is layed left from the line of the right border line or in the structure, and standing and towing shafts with inbuilt membranes, placed on the road shoulder or emergency lay-bys at a suitable distance from infrastructural installations. Shafts must be located immediately after the beginning of the lay-by so vehicles cannot drive onto it. The post must be on the inner (road) side in front of the PH wall. For the purpose of placing road markings on crossings over the central reserve, it is necessary to bridge shafts with metal covers (50 kN). For the needs of energy installations, it is necessary to lay an additional Φ125 mm pipe with separated shafts spaced at approximately 250 m.
- newly built communications medium (cable system) is used for connecting the SOS telephone posts with the communications centre and for other purposes
- the system must be of sufficient capacity to enable the simultaneous transmission (transit and local level) of information technology, signalisation and the management of devices which are installed on the motorway section via optical cable links
- the technological part of the control and communications centre must be a technological unit of the SOS telephone system design. The design must envisage the possibility of staged construction if the actual needs require this
- the SOS telephone system on this section of the motorway must be compatible and combined with the already installed SOS telephone devices on the entire area of the locally responsible communications centre.
- the transfer of all the functions of a local communications centre to the higher ranking control communications centre should also be envisaged. All SOS telephone posts must be able to be monitored on a single work station
- SOS telephone posts with standing positions, located along the motorway, must be numbered according to the numbering design
- an electricity supply system with a doubly-fed (reserve) supply must be located at power supply points which are determined by the designer. Supply sections should be 10 km in length at most.

2.9.4.1.2 Environment conditions

The SOS Telephone system must be based and built so that it operates flawlessly, reliably and securely, in spite of the normal and predictable abnormal conditions of the environment, alongside the following environmental impacts:

- in temperatures ranging from –25°C to + 60°C
- in relative humidity up to 98%
- in vibrations at a frequency of between 10Hz and 150Hz (in line with EN and ETSI standards)
- lightning: the lightning protection system must be chosen for the entire SOS telephone system in terms of the frequency of lightning strikes in the design area - a colour appendix of an isoceraunic map must be in the design documentation. On the basis of isoceraunic and statistical data, the action of lightning and the specific resistance of the ground in the design section, the designer must assess the need for calculating the values of lightning strikes, which must be an integral part of the design
- the impact of commutation phenomena, of foreign electromagnetic fields of high-voltage devices, the impact of electro-static discharges
- the impact of stray currents
- the impact of the corrosive actions of the ground.

Before starting to draw up the technical documentation for installing the SOS telephone system on a specific section of a motorway, it is necessary to have previously checked the type and volume of

environmental effects on this section and in line with this choose an adequate technical design for the entire SOS telephone system as appropriate.

2.9.4.2 Type of material

The following materials are required for the SOS telephone system:
- pipes
- cable shafts
- cables and cable joints
- telephone posts
- earth strip (25 x 4 mm FeZn).

2.9.4.2.1 Small diameter pipes

2 x PE 50 pipes can be used – 2 x polyethylene pipe – coupled, external diameter 2 x 50 mm.

Small diameter PE pipes are inserted into the pipe of an existing or new TC cable duct or are laid directly into the ground. They are intended for the placing of telecommunications cables.

For pipes directly placed into the ground, the tensile modulus of elasticity (E), measured on the product and the raw material, must be less than 800 N/mm^2, whereas it will be more than 800 N/mm^2 for a pipe drawn into a pipe of the cable network.

2.9.4.2.2 Cable shafts

The following cable shafts can be used for the SOS telephone system:
- installation cable shaft 210x80x80 cm
- standing cable shaft 210x80x80 cm
- auxiliary cable shaft Φ80 cm.

2.9.4.2.3 Cables

TD 59 10x4x0.9 GM-4 kV, TD 59 5x4x0.9 GM-4 kV and optical cable TOSM 03 6x8 II/III 0.36/0.24x3.5/17 CMAN can be used.

2.9.4.3 Quality of materials

The appropriate quality of materials for installation is defined by the design documentation, regulations and relevant technical conditions.

The Contractor must in due time before the commencement of works submit to the Supervising Engineer evidence of the quality of all the materials which will be used in the works.

The Contractor may commence the installation of the materials and products only after having obtained the consent of the Supervising Engineer.

The quality of the materials is checked with the technical information on the product and accompanying documents (ordering form, certificates, declarations).

2.9.4.4 Manner of execution

2.9.4.4.1 Telephone post requirements

SOS telephone posts must meet the following requirements:
- they must be placed in such a way that the user is looking at the driving direction at a right angle while making a call
- the SOS telephone post box must be resistant to salt, road spreading material and atmospheric effects (humidity, rain, snow, sun, low temperatures, etc.). During snow ploughing, the SOS telephone post should not be displaced or damaged due to the dynamic force of slush. The user of the SOS telephone post must also be protected from the danger of slush
- The SOS telephone post box must be designed and installed in such a way that it provides protection from voltage in the event of a lightning strike on the system. The same applies for high-voltage devices
- The SOS telephone post must satisfy the Guidelines on electromagnetic compatibility
- all points with which the user may come into contact with must be protected from excessive touch voltage. For this reason, a suitable SOS telephone post earthing system and a lightning protection system must be suitably set up, as well as the construction of the SOS telephone box and the surroundings arranged
- the standing area by the SOS telephone post must be protected and arranged in such a way that inadmissible step voltage in the event of a lightning strike is avoided
- the box of each SOS telephone post must be furnished with a red key (with bilingual text), with which it is possible to establish contact with the communication centre, and light signalisation and the SOS telephone post identification mark.
- SOS telephone posts must be linked with the communications centre via a full duplex connection
- once a connection has been established, the number of the calling SOS telephone post will appear on the operator's screen in the control centre; in the

communication centre and on the SOS telephone box an acoustic and light signal must turn on. When an operator responds to a call, mutually understandable, and quality, spoken communication must be established
- the line may only be disconnected by the operator in the communication centre. If during a connection between the communication centre and a SOS telephone post, there are calls from other posts, the number of the calling posts must appear to the operator. The SOS telephone system must be able to register calls from at least four SOS telephone posts at the same time. the communication centre must allow the operator to put on hold the first connection, verbally check the waiting call, and re-establish the connection with the first SOS telephone post
- each post must be marked so that the purpose of using the SOS telephone post is clear to the user (SOS mark) and the location of the post (number) is also clear. The SOS sign must be visible at night from a distance of at least 500 m in both directions
- the SOS telephone system must provide a physical of distance of up to 300 m between the SOS telephone posts on a pair of cables, which link posts of the same pair
- the SOS telephone system must provide for an official connection between individual SOS telephone posts and between posts and communication centre, which is only available to those maintaining the system
- the locations of the SOS telephone posts must primary ensure the safety of users while using the SOS telephone (protection with a guard rail) and must be harmonised with the envisaged locations of facilities along the road (e.g. resting areas, inside noise barriers, in front/behind viaducts/bridges, in motorway splits and before tunnels and cut-and-cover portals).

2.9.4.4.2 Control centre – requirements for buildings

The building in which the electric and electronic equipment for the SOS Telephone system must be equipped with a lightning protection system (LPS) with at least 98% effectiveness, which complies with protection class I in the event of a direct or indirect lightning strike. The lightning protection system must prevent the building from being damaged in the following situations:

- S1 step voltage and touch voltage from direct lightning strikes,
- S2 fire, explosion, mechanical and chemical factors from direct lightning strikes,
- S3 overvoltage in equipment due to direct lightning strikes,
- S4 overvoltage in equipment due to indirect lightning strikes.

When dimensioning the lightning protection system, the requirements for SOS telephone posts and the communication centre are exactly the same in terms of protection, whereby all relevant regulations and standards, including any amendments, are taken into account.

2.9.4.4.3 Requirements for electrical/electronic equipment

The control centre, which must be located, as a rule, in a building in the motorway base, must be equipped with devices which allow communication with persons at SOS telephone posts, with system power supply installations and installations which indicate established and waiting connections. If a motorway is to be built in stages, it is necessary to also envisage the staged connection of sections on the existing motorway base.

Electrical parameters for signals with SOS telephone posts, weakening of the signal, frequency of the calling signal, the alternating feeding voltage of the communication centre and at feeding locations must be defined so that the SOS telephone system works reliably and securely alongside environmental conditions in the area it is located, are as follows:
- the highest voltage which can be used to supply the SOS telephone system is 400/230 V
- the communication centre must be able to automatically control the SOS telephone posts; the operator must be immediately informed of every possible fault (information on the cause and the number of the broken post is sufficient)
- an SOS call must activate a signal in the communication centre which lasts until the operator responds; in the event of a call from a post, the appropriate identification appears on the SOS telephone post arrangement scheme, which allows the operator to quickly ascertain the location of the calling SOS telephone post
- the SOS telephone system must be the same as the system on the already built

section, to which the section in question connected,
- each supplier of the SOS telephone system must issue protocols on the operation of the system to the purchaser in order to ensure compatibility with other traffic management systems in the communication centre,
- the communication centre must be designed in such a manner that an operator with medium training can manage them and that he is appropriately familiarised with the system.

2.9.4.4.4 Power supply system – Primary power supply system

The power supply of the SOS telephone system will in principle be implemented by using a separate (or public) low-voltage network through the communication centre or power supply station to the individual SOS telephone posts by means of a SELV system.

The power supply unit in the communication centre must provide an uninterrupted supply of the central and the command board for at least 6 hours after a power failure, where it is necessary to take into account connection to a possible already built central uninterrupted power supply system in the building (quality according to IEC for category II Acu batteries – with a life of over 7 years). The same power supply system must also be used for the doubly-fed (reserve) supply of individual sections along the motorway.

All devices ranging from low-voltage cables and power supply units to connecting joints in the SOS telephone posts must comply with applicable domestic and European (EN) or international standards (ISO/IEC), or foreign national standards, if they are harmonised with the European standards.

2.9.4.4.5 Overvoltage protection of the power supply system

On sections where prior environmental impact assessments on the SOS telephone system show that the system is at risk from overvoltage, protection against surges shall be implemented, as well as on all parts of the power supply system. The specification of the protection and equipment for implementing overvoltage protection on the entire power supply system must comply with European (EN) standards and international (IEC) standards, or relevant national standards if they have been harmonised with the European standards.

2.9.4.4.6 Transmission system – Requirements for copper cable and classification of connections (design, placement, assembly, measurement and drawing up of design documentation)

In order to ensure a quality and reliable connection of SOS telephone posts with the equipment in the communication centre, the cable structure will be selected on the basis of prior environmental impact checks.

The primary structure of the communication cable must remain the same as that on existing sections of the motorway: at least 10 low-frequency star four-pin with a wire diameter of 0.9 mm. The insulation of the wire must be of foamy polyethylene, coated with a layer of full polyethylene (the skin), which must provide adequate breakdown strength: core-sheath-sheath-earth, as well as adequate breakdown strength of the insulation between the individual wires.

Longitudinal and transverse water tightness must be ensured.

The cable structure must be selected so that it offers sufficient protection against moisture entering the cable, against the effects of external electromagnetic fields and protection in line with the calculated environmental impacts. The connections in the cable must be classified as interurban (TD marking). The cable requirements must be in line with applicable national-European (EN), international or foreign national standards if they are harmonised with European standards and if a cable, which, in terms of its construction, is the same as or of a higher quality than the already laid cables along the motorway, is being determined.

In order to ensure availability and reliability of connections via a cable meets the aforementioned requirements, it is necessary to:
- Connect the links in all cable shafts by implementing sections to both SOS telephone posts via a cable termination in the SOS telephone post or on a splitter joint installed on a wall bracket underneath a post in the cable shaft
- predict the ending of a cable with a separating cable termination, which provides separation between the cable lines and the electronics in the post (network termination).
- protect the lines behind the separating cable termination with SPD surge

protection devices in line with relevant standards
- provide a spare cable approximately 3 m in length in each direction in each standing shaft
- in the installation shaft, where the cable clamp is located, provide a spare cable approximately 2 m in length in each direction.

The designing, laying and assembly of an interurban cable must be done in line with the instructions given and the technical conditions.

The constructed section of the cable connections must be in line with the instructions on checking the quality of telecommunications lines.

Measurements carried out on a built cable system and the as built design must be done in line with the Instructions on the technical recording of interurban cables, the Instructions on checking the quality of telecommunications lines and relevant national and foreign regulations and standards, and the Instructions on creating the underground cadastre of laid public utility lines on electronic media.

Measurements must be performed from the start to the end of the cable connection, without including the electronics of the post to the cable pairs (between network termination points).

2.9.4.4.7 Protection of the transmission system from environmental impacts

All prior environmental impact assessments on the SOS telephone system must be attached in written form to the technical documentation, the main design and the detailed design.

In specific cases (creeping currents), measurements should also be performed after the completion of all works on the road route.

With regard to the results of the environmental impact assessments, the design documentation must contain protection against the corrosive action of the earth and protection against mechanical, chemical and thermal damage to the cable. The construction of cable ducting using material compliant with all applicable regulations should be envisaged for the mechanical protection of cables. When constructing the cable ducting, protection against the effects of lightning in line with the Instructions on protection telecommunications cables from atmospheric discharges should be envisaged. With respect to the results of the environmental impact assessments, protection of the communications lines against atmospheric impacts, impacts of energy installations (transmission lines, DS, DTS) in normal operating conditions and when damaged, against impacts due to switches on the HV power supply network, as well as protection against electrostatic discharges and impacts of external electromagnetic fields should be envisaged and implemented in the communication centre and all SOS telephone posts. An additional special design can be drawn up for the implementation of these protection measures, which is an integral part of the design documentation for the implementation of the SOS telephone system. When devising overvoltage protection measures, the economic efficiency of implementation and remedying possible faults must be taken into consideration.

An efficient earth system, bearing in mind the danger to the system, must be implemented in all SOS telephone posts and the communication centre – in line with applicable national standards and technical regulations, European (EN), international and foreign national standards.

Elements and assemblies for overvoltage protection must be implemented so that that they respond simultaneously or in combination to all the aforementioned electrical environmental impacts. All built overvoltage protection devices, their connections and terminal elements must have appropriate electrical breakdown strength and must comply with relevant European (EN), international (ISO, IEC) and EN harmonised national standards.

In the design documentation it must be foreseen whether it is necessary to draw up an as-built design following the completion of the SOS telephone system and forward it to the Employer in written and electronic format, comprising:
- a graphical inventory of the cable ducting along the road
- technical record on the communication cable for the SOS telephone system.
- measurements carried out on the communications cable of the SOS telephone system

- measurements carried out the electronics in the SOS telephone posts and the communication centre, including technical record
- verification of the operation of the SOS telephone system
- a report on the checking of the SOS telephone system in terms of environmental impacts up to the point of termination (network termination), including overvoltage protection
- an elaboration of the as-built design for the protection of the SOS telephone system against environmental impacts.

2.9.4.4.8 Testing of cable ducting

Transiency and tightness of the cable ducting must be tested.

2.9.4.4.9 Optical transmission system

The following starting points must be taken into consideration when planning a telecommunication model:
- optical cables must be laid in cable ducting in all motorway sections,
- the system must have a sufficiently large transmission capacity, which will easily allow digital services and allow the transmission of data and video signals,
- the network must be flexible and be easily expanded, with the greatest range of possible interfaces,
- the network must be configured to protected transmitted information,
- it must be possible to upgrade it with the latest technologies,
- in line with current applicable standards and recommendations, comprehensive long-distance monitoring and management must be provided,
- the design of the construction part of telecommunications must be respected.

Toll stations, motorway bases and branches, larger facilities (bridges and viaducts), weather station, traffic marking devices and rest areas must be connected to the optical cable.

The implementation of the optical transmission system entails the laying and inserting of the cable into PEHD pipes, assembly, insertion into facilities and cable termination, connecting the cables in cable shafts at envisaged locations and the measurement of the parameters of the optical network.

A complete optical transmission system includes equipment, such as the cable (type, capacity, load), joints, distributors, FC/PC connectors, optical measuring which entails the measuring of the cable before and after it has been laid, and the final measurement which includes the drawing up of a cable measurement protocol.

2.9.4.4.10 Technical requirements for an optical cable

An optical cable must be a non-metal structure with
- 48-196 optical fibres for the main transport direction,
- 24 optical fibres for branching from the main transport direction to important locations, and
- 12 optical fibres for connecting to individual facilities.

Normally acquirable cable lengths are 2100 and 4100 m.

The cable type must comply with applicable technical regulations.

The cable must comply with European standards. SM fibres must be optimised for optical windows II and III.

A cable of the same producer and of the same quality must be installed along the entire route, whereby equality or similarity with already laid cables along the route of the motorway must be taken into account.

The bidder shall provide the following geometric, optical and mechanical characteristics:
- cable structure and type of material
- type of cable filler for moisture protection
- type of tubes
- number of tubes
- diameter of tubes
- number of tube fibres
- manufacturer and type of optical cable.

The installed cable must comply with the following requirements:

maximum attenuation at 1310 nm	0.36 dB/km
maximum attenuation at 1550 nm	0.24 dB/km
dispersion (1285 - 1330 nm)	3.5 ps/nm/km
dispersion coefficient at 1550 nm	17 ps/nm/km
operational temperature range	- 30 °C to + 80 °C

Optical fibres must be compliant with the requirements given in standard ITU-T G.652.D, and the colour marking with regulation IEC 60304.

2.9.4.4.11 Other requirements

In the inventory of materials and works, each individual phase of work must be defined as they will actually progress and the work realistically assessed in the design documentation, the main design and the detailed design.

The relevant standard for each installed material must be cited in the design documentation and in the inventory of equipment, and a certificate or declaration obtained.

The minimum permitted mean time between failures of the SOS telephone system (MTBF >3000) must be cited in the design documentation, and the permitted mean time to repair (MTTR <6 h) the system as a whole.

The system must allow remote interventions, diagnostic of operations and peripheral expansion, and be compatible with the already built system.

Operations must be managed and inspected via computer and standard interfaces by mans of software selected by the purchaser, and the possibility of “manually” operating the system must also be provided in any case.
The SOS telephone system must have anti-vandalism protection.

The warranty period for the system and all of its component parts (except consumable materials as defined by the design) is at least 3 years.

The warranty period for the cable ducting is 10 years after it has successfully been tested.

Since the attainment of the envisaged parameters will be checked, the trial operation period is at least 6 months.

2.9.4.5 Quality of execution

The works carried out in the construction of the SOS telephones must be of an adequate quality, which is defined by the design documentation, regulations and relevant technical conditions.

The Contractor must in due time before the commencement of works submit to the Supervising Engineer evidence of the quality of all the materials which will be used in the works.

All equipment and machinery used in the execution of the works must be certified and must satisfy the requirements of the design documentation, regulations and technical conditions in terms of capacity.

The Contractor may commence the execution of individual phases of work only after having obtained the consent of the Supervising Engineer.

2.9.4.6 Quality control of the execution

After the completion of the cable ducts and after the completion of other construction works, the quality of the executed cable ducting with small diameter pipes must be inspected. The following must be inspected or tested: transiency, flatness, excessive curvature, air passage and the cleanliness of the pipes must be ensured.

A calibrator must be used to inspect the quality of the constructed cable ducting alongside the simultaneous inspection of transiency, flatness, excessive curvature, air passage and to ensure the simultaneous cleanliness of the pipes. Calibration is pipes must be carried out between cable shafts at a length of approximately 500 m, while on other routes this will be done on the length of the pipe. Testing must be carried out in line with the regulations of German Telecom ZTV-FLN 40.

After the construction of the cable shafts has been completed, it is necessary to inspect the execution of the inlets (smoothed cement concrete), drainage and protective net against rodents.

The quality of the execution of the SOS telephone system must be verified in line with the requirements given in the technical requirements.

Measuring must be conducted in line with applicable technical regulations and standards. Measuring can only be performed by companies registered to do so. A written report containing the results must be compiled for all measurements. The report must make it clear whether the results of the measuring are acceptable or not. Written records must be kept for all reports.

2.9.4.7 Measuring and take-over of works

Executed works must be measured in line with general technical conditions and calculated in appropriate units of measurement.

All quantities must be measured according to the actual scope and type of works executed, which were performed within the quantity in the design documentation.

2.9.4.8 Calculation of works

The fundamentals of the calculation of executed works are specified in the general technical conditions.

All quantities of executed works need to be calculated according to the contractual unit price.

All the services needed for the full completion of the works must be included in the contractual unit price. The Contractor has no right to request later additional payment.

2.9.5 PUBLIC LIGHTING

Public lighting on roads must be built according to the appropriate design documentation and in line with the requirements given in approvals and permits from authorised organisations.

All planned works relating to public lighting of a road must be compliant with other installations on the road body. All road public lighting installations in the road body area must be installed in such a way that those installations can be maintained and repaired without damaging the pavement and hindering the maintenance of the pavement.

2.9.5.1 Description

The implementation of road public lighting entails:
- marking out,
- the acquisition and placement of poles and lights, light sources, equipment and electric cables, including all required earthworks and other works,
- verifying the quality of execution and connection,
- all other works envisaged in the plan or ordered by the Supervising Engineer, and
- entry into the register of public utility lines.

All required public lighting works must be performed according to requirements or the requirements in these technical conditions or other agreed conditions, as well as applicable lighting recommendations or applicable standards.
Public road lighting must ensure an appropriate:
- level and uniformity of luminance,
- level and uniformity of illumination,
- glare limitation and
- visual guidance.

All the cited requirements must be ensured with the appropriate classification of the relevant lamps for lighting specific pavement surfaces for a specific traffic volume.

2.9.5.2 Type of material

PC 110 pipes – polyvinyl chloride pipe, external diameter 110 mm, can be used.
PC pipes for cable ducting must have an circular cross section. They must be made from hard PC material with appropriate mechanical and other properties. PC pipes must be red in colour.

The following types of cable shafts can be used:
- thermoplastic cable shaft
- circular cross section cement concrete pipe cable shaft
- cable shaft of cement concrete with a square form, cast in situ or prefabricated.

The size of cable shafts depends on the type and number of pipes and cables.
Three types of cast-iron covers can be used, dimensioned for 50 kN, 125 kN and 400 kN of point load.

Covers with a bearing capacity of 50 kN can only be used for shafts on green surfaces which are not driven on.

Covers with a bearing capacity of 125 kN can be used for shafts on driving surfaces with a smaller load (tiles).

Covers with a bearing capacity of 400 kN can be used for shafts on driving surfaces with a higher load (pavements).

Covers must be marked with the inscription PUBLIC LIGHTING.

Low voltage cables with PVC and PE insulation and with copper or aluminium wires can be used.

Light poles 8 to 12 m high must be envisaged for public lighting, and they are mounted on typical cement concrete foundations.

Lamps, which are fixed to poles, are also used in public lighting. The lamp must contain a long-life high-pressure sodium bulb, which can withstand a high level of use and is reliable.

2.9.5.3 Quality of materials

The appropriate quality of materials for installation is defined by the design documentation, regulations and relevant technical conditions.

The Contractor must in due time before the commencement of works submit to the Supervising Engineer evidence of the quality of all the materials which will be used in these works.

The Contractor may commence the installation of the materials only after having obtained the consent of the Supervising Engineer.

The quality of the materials is checked with the technical information on the product and accompanying documents (ordering form, certificates, declarations).

Before laying the cables, it is necessary to measure the cables on drums and measure dielectric strength and insulation resistance.

2.9.5.4 Manner of execution

Public road lighting must allow traffic participants to see all obstacles which could affect driving safety and traffic order. The installation must depend on the traffic-technical characteristics of the road and difficulties which can be expected and which present a danger.

Public lighting on roads must be installed in such a way that it does not hinder traffic participants and does not pose a danger to them.

The conditions given for similar or the same work in these technical conditions must be taken into account when executing any piece of public lighting work.

2.9.5.4.1 Power supply and management

Public lighting branches must be powered with a three-phase current, and all branches provided with appropriate over-current protection. At turn-on points, there must be equipment to manage the switching on and switching off of public lights, as well as to manage the switching on and switching off of reduced lights at night between 23:00 and 05:00 or in line with the arrangement of the surroundings.

If there are several turn-on points they must all be synchronised.

Power supply cables in asphalt surfaces must be laid in cable ducting of PVC 110 mm pipes and cement concrete Φ60 cm pipe cable shafts with a 60x60 cm cover and 40x40 cm cable shafts with 35x35 cm covers underneath the lamps.

Cables in green surfaces and other non-asphalt surfaces can be laid directly into the ground.

2.9.5.4.2 Limiting glare

Pavements on motorways and other roads, with a high traffic load, must comply with the requirements for class I glare limitation and other roads must comply with the requirements for class II. The limit values for classifying the class of glare limitation depend on the illumination of the environment, the lightness of the surroundings, the speed of traffic participants, AADT (annual average daily traffic), the speed limit, etc.

Provisions concerning the permitted limit values for limiting psychological and physiological glare are given in more detail in relevant recommendations and in applicable recommendations for illumination, and in applicable standards.

2.9.5.4.3 Visual guidance

With the appropriate, systematic classification of lights, the safe guidance of vehicles in the dark, especially when the pavement is wet, should be ensured.

2.9.5.4.4 Adaptation

Through the adequate transition of light, changes in conditions will be adapted to, if

- the travel speed on a road is at least 60 km/h,

- road lighting stops working, and luminance is at least 1 cd/m2,
- the ratio of luminance between two consecutive road sections is more than 10 : 1.

An adaptation time of 10 seconds shall be taken into account.

2.9.5.5 Quality of execution

2.9.5.5.1 Luminance

Luminance, which is important for assessing visibility and visual comfort, is defined by the level of luminance L and the uniformity of luminance U. The required values of mean luminance L and transverse and longitudinal uniformity of luminance U_min for public road lighting in settlements depends on the illumination of the surroundings, luminance of the surroundings, the speed of traffic participants, AADT (annual average daily traffic), the speed limit, etc.

The value 1.25 L_{sr} should be taken into account during planning for the effect of ageing and pollution.

2.9.5.5.2 Illumination

In exceptional cases (for carriageways with a travel speed limit of up to 60 km/h and a light traffic load) it is possible to use illumination of the carriageway E and uniformity of carriageway illumination for the visibility assessment instead of luminance. The required values for mean illumination E and the ratio of uniformity of illumination depend on the illumination of the environment, the lightness of the surroundings, the speed of traffic participants, AADT (annual average daily traffic), the speed limit, etc.

The value 1.25 E_{sr} should be taken into account during planning for the effect of ageing and pollution.

2.9.5.6 Quality control of the execution

The quality of the implementation of road public lighting should be checked by measuring
- luminance,
- illumination and
- the reflective capabilities of the pavement surface.

The required values which must be ensured are given in the design documentation.

Measuring must be conducted in line with applicable technical regulations and standards. It is conducted only by companies registered to do so. A written report containing the results must be compiled for all measurements. The report must make it clear whether the results of the measuring are acceptable or not. Written records must be kept for all reports.

2.9.5.7 Measuring and take-over of works

Executed works must be measured in line with general technical conditions and calculated in appropriate units of measurement.

All quantities must be measured according to the actual scope and type of works executed, which were performed within the quantity in the design documentation.

2.9.5.8 Calculation of works

The fundamentals of the calculation of executed works are specified in the general technical conditions.

All quantities of executed works need to be calculated according to the contractual unit price.

All the services needed for the full completion of the works must be included in the contractual unit price. The Contractor has no right to request later additional payment.

2.9.6 WATER SUPPLY LINES

To build water supply line, appropriate design documentation needs to be drawn up and suitable permits from the electric supply company and other institutions obtained.

Any modification, with which the responsible designer agrees, shall also be approved by the Supervising Engineer prior to commencement of works.

The route of the water supply lines must be in harmony with the existing arrangement of the different installations in the public traffic surface area and with the conditions prescribed by the operators of the installations and traffic surfaces.

A water supply line may not be built underneath the pavement. Their crossings and directing underneath pavements must be done in a way that it is possible to repair the water supply installations without destroying the pavement.

2.9.6.1 Description

The execution of a water supply line entails:
- marking out,
- creation of substrate,
- acquisition and installation of water supply line installations,
- pressure and sanitary testing with disinfection,
- connection to the network,
- all required earthworks, which must be conducted according to the requirements in the design documentation and these technical conditions, unless the Supervising Engineer determines otherwise, and
- entry into the cadastre of underground installations.

2.9.6.2 Basic materials

The following materials are required when building a water supply line:
- materials for the bedding course,
- materials for the water supply line: pipes, joints (phase pieces), equipment (reinforcement) and hydrants, and
- materials for facilities.

2.9.6.2.1 Materials for the bedding course

The bedding course underneath the water pipe line installation must, as a rule, be made from fine-grained aggregate, and only exceptionally can it also be made from a mixture of cement concrete.

2.9.6.2.2 Materials for the water supply line

2.9.6.2.3 Pipes

The following are primarily used for water supply lines
- pipes made from plastic materials,
- steel pipes and
- cast iron pipes.

The design documentation should specify the type of pipes for the water supply line.

2.9.6.2.4 Pipes made from plastic materials

Hard polyethylene pipes (for 6 and 10 bars of pressure) should be used for a water supply line; they should be resistant to mechanical impacts and aggressive environmental impacts, and easy to install.

2.9.6.2.5 Steel pipes

Seamless steel pipes and seam-welded pipes, which comply with the requirements in the design documentation, may be used for a water supply line.

2.9.6.2.6 Cast iron pipes

Cast iron pipes for a water supply line (ductile cast metal) must comply with the envisaged conditions in the design documentation.

2.9.6.2.7 Joints, equipment and hydrants

All the required joints, equipment (valves, air vents) and hydrants for a water supply line must be specified in the design documentation and comply with those requirements.

2.9.6.2.8 Materials for facilities for a water supply line

The primary facilities which are needed for a water supply line are:
- shafts and chambers,
- supports and anchored blocks and
- collectors.

Cement concrete and reinforcing steel are the primary materials for building facilities for water supply lines.

2.9.6.3 Quality of materials

The quality conditions of all materials, which are envisaged for water supply line construction, must be specified in the design documentation. If they are not, the relevant provisions in these technical conditions or the agreed documentation of the producer apply to the quality of the materials. The validity of the conditions is determined by the Supervising Engineer who must approve each material prior to its use if the water supply line is being built in special conditions.

The Contractor must in due time before the commencement of works submit to the Supervising Engineer evidence of the quality of all the materials which will be used in the construction of the water supply line.

The quality requirements of the primary materials are threshold values unless agreed otherwise. The maximum threshold values are determined by the Supervising Engineer in relation to the characteristics of the individual task.

2.9.6.4 Manner of execution

In a road area, a water supply line must, as a rule, be built away from the carriageway or under footpaths, and only exceptionally can it be built underneath the pavement.

When crossing a road, the pipeline may be built in a special collector or protective cement concrete duct. These must protrude at least 3 m on each side from the fill toe. Inspection shafts should be built at both ends of the protective duct.

The minimum clear distance of the water supply line from other water supply lines, installations and facilities is given in Table 2.9.9.

Wastewater sewerage must be built underneath the water supply line. If this is not possible, the water supply line must be built inside a protective duct.

Table 2.9.9: Minimum clear distance of a water supply line from other water supply lines, installations and facilities

Type of line, installation, structure	Minimum clear distance of water supply line	
	Parallel course [m]	course at crossing [m]
- power cable	0.5 to 2.0	0.5
- telecommunications cable	1.0	0.5
- gas pipeline	0.5	0.3 to 0.6
- hot-water line	0.5	0.3 to 1.0
- residential or industrial building	4.0	
- main road (outside the fill toe)	3.0	1.2
- sewerage	1.5	0.4

2.9.6.4.1 Obtaining materials

In due time prior to commencement of water supply line works, the Contractor is obliged to inform the Supervising Engineer of all types of materials he intends to use and to submit appropriate evidence of their quality.

All required properties of the materials must be met. The Contractor shall eliminate and specially mark material which does not meet the specified requirements.

2.9.6.4.2 Substrate preparation

It is possible to install hard polyethylene pipes:
- directly onto suitably prepared (levelled and fortified) foundation soil – excavation formation or
- on a bedding course of aggregate (sand).

Steel and cast iron pipes can also be built directly on suitably prepared foundation soil (sifted soil).

The bedding course may not freeze during the installation of water supply line pipes.

2.9.6.5 Installation

2.9.6.5.1 Bedding course

The aggregate bedding course or cement concrete mixture can be placed levelled to ensure the pipes fit suitably. The bedding course materials, as a rule, have to be placed manually because of space restrictions.

The Supervising Engineer specifies the manner and conditions of installing the water supply line pipe bedding course.

2.9.6.5.2 Pipes and joints

The Contractor may only begin laying the water supply line pipes after the Supervising Engineer has taken-over the prepared substrate.

When joining water supply line pipes, the instructions of the pipe manufacturer must be taken into account. As a rule, the following should be coupled:
- hard polyethylene pipes with adequate joints or welding,
- steel pipes by means of welding and
- cast iron pipes with joints (sealed with hemp cord and lead) or with bolted flanges sealed with appropriate rubber or other type of seal).

All steel pipe water supply lines must be appropriately protected from corrosion (primarily cathodic protection), especially at points of crossing with other pipelines and installations. Pipe insulation must comply with drinking water requirements.

Before connection to the water supply network, the pipeline should be rinsed with water so that it is mechanically clean and disinfected (with water with added chlorine). The responsible body must approve the connection of the pipeline to the water supply network.

2.9.6.5.3 Equipment and hydrants

A valve must be fitted to each point where a branch line separates from the main pipeline, alongside a hydrant. It must be at least 25 cm from the shaft walls and bottom.

Hydrants must be installed
- at least 80 m apart in settlements and
- 100 m to 200 m apart outside settlements.

If the hydrants will also be used for venting the pipeline, they must be (and the same goes for air vents) installed at the highest points of the pipeline.

2.9.6.5.4 Facilities

All water supply line facilities must be built in line with the design documentation and devised according to the provisions applying to identical or similar works in these technical conditions.

The size of the shaft must be adapted to the diameter of the main pipeline and the installed equipment. The shaft cover must be adapted to the traffic load.

The opening through which a pipeline passes through the wall of a structure must be enlarged by at least 2.5 cm. In water supply line structure there must not be other installations (e.g. power line, gas pipeline), unless they meet special safety requirements.

2.9.6.5.5 Backfilling

The provisions in these technical conditions apply to the backfilling of trenches for water supply lines. They may be backfilled only after pressure testing.

Compaction of the backfilling of water supply line pipes must be done manually, at least 50 cm above the top (in suitably thick layers). The following method of compacting must be approved by the Supervising Engineer depending on the position of the pipeline in the road body.

2.9.6.5.6 Quality of execution

The quality of the executed works must comply with the requirements in these technical conditions and the conditions in the design documentation.

The quality requirements of the primary materials are threshold values unless agreed otherwise. The end threshold values must be specified by the Supervising Engineer.

2.9.6.5.7 Quality control

The scope of testing as part of internal and independent inspection during the execution of water supply line works must be specified by the Supervising Engineer on the basis of submitted documentation according to the requirements in these technical conditions and on the basis of the progress of the work.

The Contractor must ensure pressure testing of the built and appropriately secured water supply line in relation to the type of pipes used.
Pressure testing (with water) of a plastic material pipe water supply line must be done according to the manufacturer’s instructions.

Pre-testing of a filled and vented pipeline must be done in such a way that the prescribed operational pressure is achieved and maintained for 24 hours. During this time any defects must be remedied.

The test pressure prescribed by the pipe manufacturer or the design documentation is

achieved during the main test. This test pressure must be approximately 50% higher than the planned operational pressure. The duration of the main test depends on the length of the pipeline and must last 30 minutes for each 100m of pipeline. The water, which is absorbed by the pipe during the test, must be refilled every 30 minutes.

Once the testing of individual sections of the pipeline has bee completed, the entire network must be tested in the same way. If defects are detected during the test, testing must be stopped, the defects remedied and the testing repeated.

A record must be kept during the pressure test, which is signed by the Supervising Engineer and the Contractor's representative.

Pressure testing of a steel or cast iron pipe water pipeline must be performed with working pressure, which then must be raised to the boundary of the test pressure of 15 bars. This pressure must be held in the pipeline for 6 hours. If the pressure does not fall by more than 0.1 bar within those 6 hours, the pipeline can be considered water-tight.

An authorised organisation should perform the disinfection and sanitary testing of water supply lines. The testing certificate must contain an assessment of the quality of the built water supply line.

2.9.7 GAS PIPELINES

Gas pipelines for natural gas and town gas must be built according to the design documentation and on the basis of appropriate permits and approvals from responsible organisations. The gas pipeline route must be harmonised with the current state of the different installations in the public traffic surface area and with prescribed conditions.

As a rule, a gas pipeline must be built into the ground and in special conditions it can be built above the ground.

A gas pipeline may not be built underneath a pavement. Crossings of gas pipelines and roads must be done in such a way that the pipeline in the road body can be replaced without demolishing the pavement.

According to use, gas pipelines are classified into main, transmission, feeding and connecting. In terms of gas pressure, pipelines are classified into:
- low pressure gas pipelines (pressure up to 1000 mm of the water column, most commonly 200 to 250 mm),
- medium pressure gas pipeline (pressure from 1000 mm of water column to 1 bar) and
- high pressure gas pipeline (with pressure of above 1 bar, to approximately 40 bars).

2.9.7.1 Description

The execution of gas pipelines entails:
- marking out,
- execution of substrate,
- acquisition and installation of gas pipeline installations,
- pressure testing,
- all required earthworks, which must be conducted according to the requirements in the design and items 2.2.2.1 and 2.2.2.4 of these technical conditions, unless the Supervising Engineer determines otherwise, and
- entry into the cadastre of underground installations.

2.9.7.2 Basic materials

The following materials are required when building a gas pipeline:
- materials for the bedding course,
- materials for the gas pipeline: pipes, fittings (reinforcement), collectors and
- materials for facilities.

2.9.7.2.1 Materials for the bedding course

The bedding course under a gas pipeline must, as a rule, be made from fine-grained aggregate.

2.9.7.2.2 Materials for a gas pipeline - pipes

As a rule, the following should be used for a gas pipeline
- steel seamless pipes or seam-welded pipes (for high-pressure and medium-pressure gas pipelines),
- cast iron pipes and
- polyvinyl chloride pipes (for low-pressure gas pipelines only).

The pipes must satisfy the conditions in the design documentation.

Steel pipes for gas pipelines must be suitable protected against corrosion, either at the factory or mechanically at the site.

2.9.7.2.3 Equipment

All the necessary valves, vents and other small equipment for gas pipelines must be specified in the design documentation and satisfy these requirements.

2.9.7.2.4 Collectors

All the necessary collectors need to collect and drain condensed water vapour and gasoline and any water must be specified in the design documentation and comply with the envisaged conditions.

2.9.7.2.5 Materials for a gas pipeline facilities

The primary facilities for a gas pipeline are
- shafts (with shut-off devices),
- pressure reducing stations (underground and above ground) and
- supports and anchored blocks.

The primary materials for constructing the aforementioned gas pipeline facilities are:
- cement concrete and
- reinforcing steel

2.9.7.3 Quality of materials

The conditions for the measurements and quality of all materials, which are planned to be used in building a gas pipeline, must respond to the characteristics of the area and the safety factor specified in the design documentation. If they do not, the relevant provisions in these technical conditions or the agreed documentation of the producer apply to the quality of the materials. The validity of the conditions is determined by the Supervising Engineer who must approve each material prior to its use if the gas pipeline is being built in special conditions.

The Contractor must in due time before the commencement of works submit to the Supervising Engineer evidence of the quality of all the materials which will be used in the construction of the gas pipeline. The quality requirements of the primary materials are threshold values unless agreed otherwise. The maximum threshold values are determined by the Supervising Engineer on the basis of the characteristics of the individual task.

2.9.7.4 Manner of execution

In a road area, a gas pipeline must be built below the ground in a special protective conduit.

The protective conduit for a gas pipeline must be sealed at both ends, and its internal diameter at least 10 cm larger than the diameter of the gas pipeline running through it.

The crossing of a gas pipeline with a road must be executed at a right angle. When running alongside a road, the gas pipeline must be laid underneath traffic surfaces with the lightest traffic load (cycling paths, footpaths) and outside the road body where possible.

The gas pipeline and water line are placed below the pavement with the minimum depth of the top of the pipe being 1.0 m at the distance from the road edge, as stipulated for the high and low pressure network.

A gas pipeline with an operating pressure above 16 bars is placed along a distant road at a minimum distance of 10 m from the outer edge of the carriageway, along a connection and collector road at the distance of 5.0 m, and along an access road and a road with low traffic load at the minimum distance of 2.0 m from the lower edge of the road embankment slope.

A gas pipeline with the operating pressure of up to 16 bars is placed at a minimum distance of 2.50 m from the edge of the carriageway.

If in exceptional circumstance a gas pipeline needs to be built on an overpass above a road, the clear opening between the lower pavement and the gas pipeline is at least 4.7 m.
As a rule, gas pipelines are not permitted to be installed in pedestrian tunnels.

Shut-off devices on a gas pipeline must be at least 10 m from the edge of the carriageway, and exhaust and venting devices at least 50 m away. The minimum clear distance of a gas pipeline from other installations in the road body area or in the vicinity of it is given in Table 2.9.10.

Other safety distances, which must be taken into account during planning and construction, are given in relevant regulations.

Table 2.9.10: Minimum clear distance of a gas pipeline from other lines, installations and facilities

Type of line, installation, structure	Minimum clear distance of gas pipeline	
	Parallel course (m)	At crossing (m)
In settlements:		
- PVC gas pipeline:		
- from water supply line and sewerage	0.2	0.6
- from main hot water supply line	1.0	1.0
- metal gas pipeline:		
- from water supply line, sewerage, hot water supply line	0.2	0.3
- power cable	1.0	0.5
- telecommunications cable	1.0	0.5
- pipeline for chemicals	0.2	0.6
- petrol station	-	5.0
- sewerage	0.2	0.3
Outside settlements:		
- power line	0.5	5.0
- telecommunications cable	0.3	1.0
- pipeline for chemicals	0,3	1.0
- petrol station	-	30.0
- sewerage	0.3	1.0
- hot water supply line	0.3	1.0

2.9.7.4.1 Procurement of materials

In due time prior to commencement of gas pipeline works, the Contractor is obliged to inform the Supervising Engineer of all types of materials he intends to use and to submit appropriate evidence from the producer of their quality.

All the properties of the materials required in the design documentation must be provided. The Contractor shall eliminate and specially mark material which does not meet the specified requirements.

2.9.7.4.2 Substrate preparation

Gas pipeline pipes must be installed directly on suitably uniformly level and fortified bedding course of natural or crushed mineral aggregate (sand). It must be spread as evenly as possible on the levelled bottom of the excavated trench, which is 0.6 to 1.2 m wide (in relation to the diameter of the pipe), approximately 10 cm thick, and approximately 1.5 m deep, to ensure the pipes rest suitably. The bedding course materials, as a rule, have to be placed manually because of space restrictions.

The bedding course may not freeze during the installation of gas pipelines.

The Supervising Engineer specifies the manner and conditions of preparing the substrate for a gas pipeline.

2.9.7.4.3 Installation - pipes

The Contractor may only begin laying the gas pipeline pipes after the Supervising Engineer has taken-over the prepared substrate.

When installing pipes for a gas pipeline, care must be taken not to damage the anti-corrosion protection.

Gas pipeline pipes must be joined by means of welding or appropriate joints, sockets or flanges, according to manufacturer's instructions.

All steel pipe gas pipelines must be suitably protected from corrosion in line with the requirements in these technical conditions.

In order to reduce the effect of stray currents, the gas pipeline must be divided into appropriate sections with dielectric flanges.

2.9.7.4.4 Equipment

All required equipment (reinforcement) for gas pipelines must be protected from corrosion and built according to the detailed plans as part of the design documentation.

Each modification to the method of installation must be approved by the Supervising Engineer with the consent of the designer.

2.9.7.4.5 Collectors

The collectors intended to collect and drain condensed water vapour and gasoline and any water must be welded to the gas pipeline at the lowest points.

The distance between the collectors depends on the shape of the terrain and any installations in the ground, which need to be avoided.

The method of draining the collected liquid from the containers must be specified in the design documentation.

2.9.7.4.6 Facilities

All gas pipeline facilities must be built according to the design documentation and devised according to the provisions applicable for identical or similar works.

Shafts (with shut-off devices) for gas pipelines must be watertight, their size adapted to the diameter of the gas line pipe and equipment, which will be installed in it. Besides adequate installations for closing the gas pipeline, the shaft must also contain pipes for draining collected liquid, a vent pipe and a pressure gauge for checking gas pressure in the pipeline. Access into the shaft must be from above through an opening which must be made so it is closed with an appropriate cover.

An independent structure for a pressure reducing station is only required for high-pressure gas pipelines with a large volume of gas. In other situations, the pressure reducing station can be incorporated into the underground shaft or on an external wall of a nearby building.

All installations in the pressure reducing station must be separated from the gas pipeline by means of dielectric flanges. The structure for the pressure reducing station must be earthed, watertight and built from non-flammable material.

2.9.7.4.7 Backfilling

The provisions in item 2.2.2.4 of these technical conditions apply to the backfilling of trenches for gas pipelines. They can only be backfilled once the welds have been checked and the pressure tested.

Compaction of the backfilling of gas pipeline pipes must be done with appropriate devices in order not to damage the pipe protection and ensure an appropriate density of the placed material. The backfilling compaction method must be approved by the Supervising Engineer dependent on the location of the gas pipeline in the road body.

2.9.7.5 Quality of execution

The quality of the executed works must comply with the requirements in items 2.2.7.6.3 and 2.2.7.6.4 in these technical conditions and the conditions in the design documentation.

The quality requirements of the primary materials are threshold values unless agreed otherwise. The end threshold values are specified by the Supervising Engineer.

2.9.7.6 Quality control of the execution

The scope of testing as part of internal and independent inspection during the execution of gas pipeline works must be specified by the Supervising Engineer on the basis of submitted documentation according to the requirements in these technical conditions and on the basis of the progress of the work.

The Contractor must ensure the quality of all welds is checked via a radiographic procedure:
- 30% of gas pipeline pipe welds outside the shafts and protection ducts, and
- 100% of pipe welds built into the shafts and protective ducts.

The tightness of welds must be checked via air pressure testing in line with the conditions in the design documentation.

Prior to laying the gas pipeline pipes in the trench, the electric strength of the pipe protection with voltage, as specified in the design documentation for the cathodic protection of gas pipelines, must be tested. Such checks also need to be carried out on the pipes once they have been laid in the trench but not yet backfilled.

If defects are detected during the quality checks, the checks must be stopped, the defects remedied and the checks repeated.

The Supervising Engineer must participate in during the checking of the quality of the execution of the gas pipeline.